Metals and Alloys

THE MAGAZINE OF METALLURGICAL ENGINEERING

PRODUCTION · FABRICATION · TREATMENT · APPLICATION

JUNE 1942

Increased production, longer uninterrupted service, and reduced fuel consumption have been effected in many types of furnaces in the metal-working industries, by the correct application of refractories—either heavy firebrick or insulating firebrick.

B&W Refractories Engineers are available to assist you in such problems. They know not only a great deal of the theory of industrial furnaces, but have a practical knowledge and experience that commands the respect of brick layers and operators alike. Their *business* is refractories engineering.

The cooperation of engineers from the home office may also be called upon.

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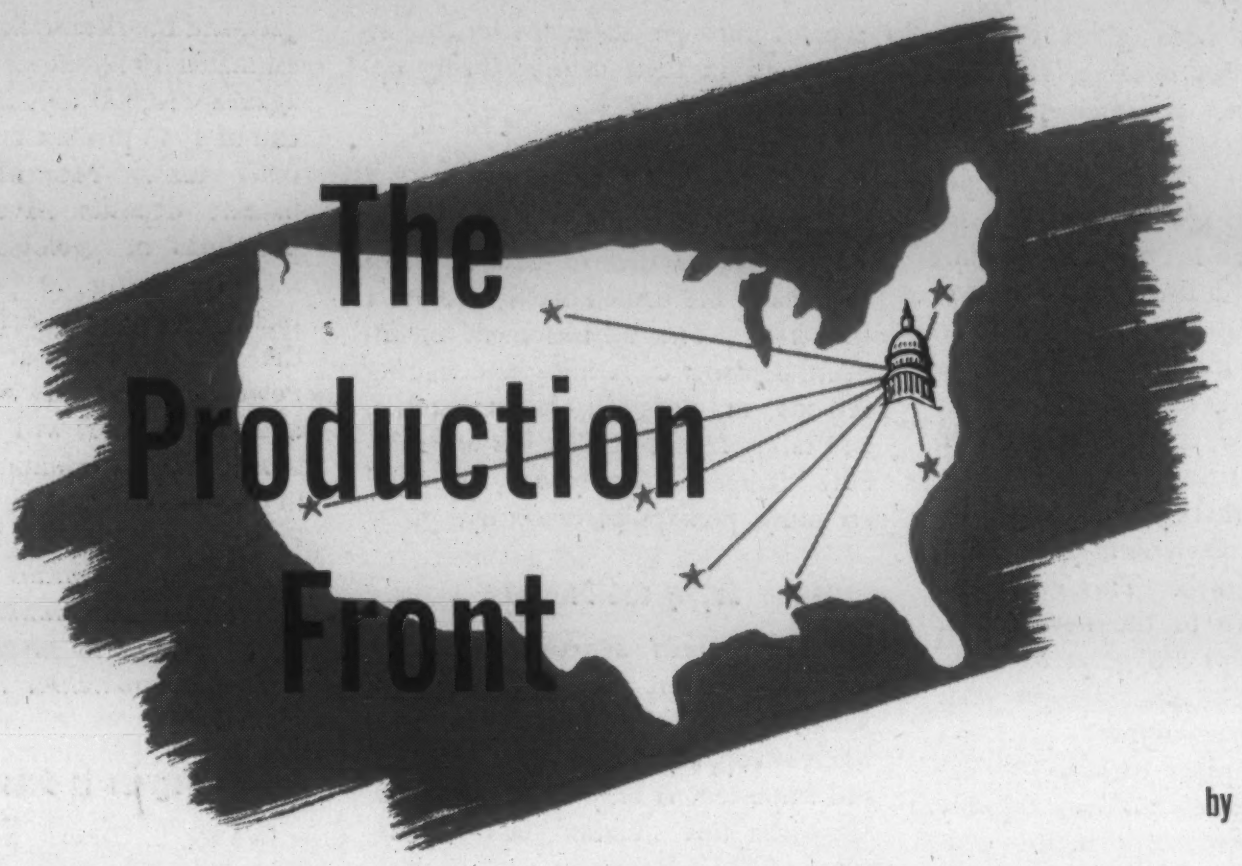


by Harold A. Knight
Associate Editor

The steadily increasing activity on the production front forms a fitting backdrop for the elevation this month of the popular column, "The Production Front," to the status of a full-fledged department. Now written by our new associate editor, Harold A. Knight (see page 953), this department will review and interpret war-production developments in their relation to the engineer in the metal industries. Mostly it will be an all-in-one-place summary of the month's major moves on the war-production front, a frank appraisal of progress, a peek or two behind the scenes in Washington and elsewhere, and—we hope—an occasional hint of things to come. In the hands of Mr. Knight, who has been reporting and interpreting metal-industries news for a score of years, this new department is expected to attain a top position among current "commentaries" in the industrial press.
—The Editors

Usually industry moves these days in tempo with world events—a faster war pace means faster planning and manufacture. Since Pearl Harbor world events, as regards their bearing on the American people, have moved with cataclysmic rapidity. Japan has temporarily conquered a vast empire. Russia has exploded with fair conclusiveness the myth of German invincibility. Germany has proven that submarines can operate with almost paralyzing havoc 3000 miles from home bases. So-called conquered Europe has shown that "conquering" is only a relative term, what with sabotage, slow down, and killing of German police in occupied territories.

During the past month Americans have learned that the "impossible" production programs for airplanes, tanks and guns, have not only been possible but are being accomplished, though few actual figures are given out.

American engineers have again shown their ingenuity by using alternate or substitute materials. As Walter S. Tower, president of the American Iron and Steel Institute, stated at the annual convention in New York last month, "The skill in producing low-alloy steels and alternate specifications for the more exacting requirements of the past will have brought evolutionary changes in the art and practice of steel-making which might not have come for a generation, if ever, under other circumstances. Whole groups of steels popular and prominent in the past may now find themselves permanently relegated to secondary place."

"Necessity, Mother of Invention"

"A new phase of relationship of Bessemer to open hearth may have been started. Potential pig iron capacity may no longer be able to count on depleted scrap supply. Merits of electric furnaces versus open hearth grades of steel will have to be worked out. The impetus given to light metals, aluminum and magnesium, will have done in a few years what might never have happened. Plastics make enormous strides. Plywood crops up in unexpected places."

Not only are purely civilian manufacturers being forced to switch to war lines, but even important branches of the iron and steel industry, presumably basic war manufacturers, are forced to changeover or go out of business. Thus in this era of lightness gray iron foundries do not have enough war work and must alter products. Steel castings are suggested, but this is more difficult than might appear.

The past month, too, has revealed that our Army and Navy must give close heed to scarcity-considerations whereas previously they had unlimited entree to all materials. Out of the window are copper for trays for the Navy—you can't kill enemies with trays. Tires must be conserved by our Army. Our military must revise specifications to allow use of secondary or scrap metals, instead of virgin, where possible. Greater use must be employed of lead, which is the most abundant base metal, in the place of copper, our No. 1 critical metal.

Puts Teeth Into Enforcement

May has been featured by government enforcement in earnest of laws in process of formation and change these many months. Prominence in

(Continued on page 908)

the press has been given to users of chromium, for instance, for other than government-sponsored purposes. Moreover a better civic conscience has crept over our 130,000,000 people. John Q. Public now realizes that his use of more than his quota of gasoline may mean the death of an oil-tanker sailor, the failure to turn in a tooth paste tube may mean the loss of a soldier through a defective gun bearing.

Important, too, is the edict of WPB that any war plants not completed by the end of this year, except for aluminum and magnesium production, must be abandoned. This might apply for instance to the new copper refinery of Phelps Dodge at Morenci, Ariz., costing $28,000,000—yet what is more vital than copper?

Speaking of plans to add 10,000,000 tons of steel making capacity Walter S. Tower said: "Such a program has little chance of making any early contribution to steel supply for war uses. It already seems doubtful whether that program will be completed. However this war can be fought and won with the steel which we now make. The United States alone has double the critical material strength, measured in tons of steel, that is now possessed by all the enemy countries."

"Have to Eat Our Seed Corn"

When speaking to purchasing agents, on the subject of suspending expansion of steel and copper facilities Leon Henderson stated in his usual colorful manner: "We may have to eat our seed corn."

More and more thought in industrial circles is directed secondarily toward peace and how "guns can be turned into ploughshares." As Mr. Tower expressed it, "With frozen costs and inflated taxes, a decline in prices or in volume of production when the war ends could quickly bring acute trouble to steelmakers."

Dr. Lawrence W. Bass, head of the New England Industrial Research Foundation, recently declared that New England will continue to face constantly increasing industrial competition from regions richer in raw materials, nearer to fuel supplies and less generous to labor. He suggested that New England's answer should be quality of product, operation, management. He concluded :"History records many cases of peoples who have risen far beyond the levels of their natural resources through sheer power of intelligence in their manufacturing operations."

Bomber Plants on Bean Fields

Undoubtedly the experience of New England is parallel to that of other sections of the United States, and other countries. The establishment of industrial plants in farming and mining regions to promote decentralization and safety from bombing has undoubtedly changed radically our industrial economy, perhaps permanently.

Supply and Demand

Known needs of copper for our own war effort and lend-lease is 3,500,000 to 4,000,000 tons for 1942, whereas copper in sight, both domestic and imported, is only 2,000,000 tons. Moreover this situation takes cognizance of the cessation of civilian uses. Much copper in South America is piled up at refineries and docks awaiting ships. More intensive sinkings would cut delivery of much of the expected 2,000,000 tons. The new ruling of the government that all expansion of plants cease at the end of the year may curb copper output. The answer is stricter substitutions in place of the red metal.

The latest authentic reports of steel, as given by Walter S. Tower, Steel Institute head, mention a new record production of nearly 84,000,000 tons yearly. Electric furnace production has risen to more than three times the output for any year prior to 1940. For four successive quarters the rate of operations for steel generally remained above 95 per cent. It has been above 90 per cent for over 21 months, a record-long span. American steel plate makers are producing nearly twice the tonnage of plates that the rest of the world can roll. June production is predicted at 1,000,000 tons.

Plain Steel to Top Fabrication.

Ability to make steel generally for war will soon be in excess of ability to fabricate into ships, aircraft, tanks, guns, etc., states Mr. Tower.

Production of slab zinc this year will be close to 1,000,000 tons against 400,000 tons five years ago. This is one of the most striking gains for a "Cinderella" metal. Zinc has been one of the least-rationed metals because of comparative abundance.

Aluminum production grows in a Jack-and-the-Beanstalk manner. The estimated 1942 output is 400,000 tons against 112,000 tons in 1936. By the end of 1943 production will be 1,000,000 tons. Meanwhile Arkansas bauxite deposits have exceeded expectations of geologists, the district now furnishing 40 per cent of our total. Veins are richer and nearer the surface than at first thought. Power developments at Grand Coulee and Bonneville will bring 30 per cent of U. S. aluminum production to the Northwest, easily available to Pacific Coast aircraft plants.

All of which means that the American rate of aluminum production is almost certain to surpass that of the entire Axis sometime in 1943, if not sooner.

Progress in Substitutions

Walter S. Tower, president of the American Iron and Steel Institute, gave striking examples of alternate materials and percentages. Though his examples may not have been strictly new, they are appropriate to mention because of the prestige and authority of the speaker. He listed: "The possibilities of using larger amounts of ore in open-hearth charges, the proven versatility of molybdenum alloy steels, the development of a type of rolled armor without the use of nickel, and the creation of a whole series of national emergency specifications."

Conservation of nickel, chromium, vanadium and other metals was treated by H. J. French, senior technical consultant, metallurgical and specifications section, Iron and Steel WPB branch, in an address before the Steel Institute. He said that an increase of 0.5 per cent manganese above a usual 0.75 per cent in, say, one fifth of the expected alloy steel production, might conserve chromium.

To conserve vanadium the amount in high speed steels has been decreased to a minimum in all cases, states Mr. French. Some of the high-vanadium grades such as 18-4-2 (tungsten, chromium, vanadium) have been eliminated and use of vanadium in all other grades of alloy and straight carbon tool steel dropped.

The use of tungsten for high speed tool steels has been allocated on the bases of 25 per cent in the tungsten type and 75 per cent in molybdenum steels. However, increased domestic and South American supplies are to be expected.

Zirconium, titanium and boron, while now in use, may take some of the load off other alloys, states Mr. French.

Allocation and Priorities

Tantalum, the entire output of which is going into vital war uses, has been placed under complete allocation control by the Director of Industry Operations.

For certain ferrous materials such as wire and nails, makers of non-metal food containers have been given an A-1-c rating since the previous A-7 rating was not high enough. Users of metal containers, such as drums, have been asked to use substitute materials.

Suppliers of maintenance and repair parts to copper and brass mills have been given an A-1-c rating to replenish inventories when they have filled orders bearing an A-1-c or higher rating from the mills. The previous rating of A-3 was insufficient.

Production of alloy steel is being subject after June 1 to monthly melting schedules issued by the Director of Industry Operations. Amendment No. 3 to Supplementary Order M-21-a provides that no iron or steel may be melted or delivered to fill orders with ratings lower than A-1-k except for certain National Emergency and other low alloy steels, which may be produced for orders down to A-3 ratings. Restrictions apply to steel containing chromium, cobalt, molybdenum, nickel, tungsten or vanadium.

Preference rating order P-74, which grants a rating of A-1-c to allow producers to obtain materials for construction of heat-treating furnaces has been extended to midnight, June 30.

Suppliers of materials used in the construction of vital aluminum and magnesium plants have been advised by WPB that deliveries should be made on schedule even though subsequent orders assigned under Preference Rating Order P-19-1 carry higher preference ratings.

Indian kyanite, a super duty refractory used in furnaces where extremely high temperatures are necessary, has been placed under complete allocation control.

Amendments to Supplementary Order M-1-d are designed to place firmer control over the segregation and sale of aluminum scrap. That with less than 15 per cent aluminum content is not affected.

Shipments of brass mill, wire mill and foundry copper products were limited to those with ratings of A-1-k or higher by WPB on May 7, the previous dead line having been an A-10 rating.

Suppliers of material used in production of aircraft were given a rating of A-1-a on May 8 by WPB.

Supplementary Order M-9-b which controls copper scrap was amended May 9 to include ingots.

Metallic zinc was placed under complete allocation control June 1 by WPB. Zinc oxide and zinc dust were placed under the pool arrangement by which all zinc has been controlled heretofore.

The Director of Industry Operations has extended until Oct. 31 Order M-2-b which provides for complete allocation of magnesium.

The May lead pool was set at 15 per cent of March production, unchanged from previous months.

Calcium silicon, widely used for making high-strength cast irons, has been placed under complete allocation control, under General Preference Order M-20-a, effective May 30.

Beryllium, used for making hardenable copper-beryllium alloys and, more recently, aluminum-beryllium alloys has been placed under complete allocation control, Order M-160. Users must make requests for allocation on form PD 496 by the 20th of the month preceding delivery, filing also a monthly report to WPB on form PD-497, a form which must also be used by anyone having as much as 10 pounds in his possession.

Simplification and Standardization

A simplified stock list of standard sizes of bolts, nuts, rivets, screws and other fastenings has been issued by OPA reducing the number of stock sizes from about 450,000 to 250,000.

Cessation and Limitation

WPB has ordered an end of manufacture of cooking appliances by large producers after July 31, but permits production of a limited number of simplified and light-weight models by smaller companies for civilian use.

The Division of Industry Operations has banned new installations of air conditioning and commercial refrigeration except for war and essential civilian needs.

One of the most sweeping conservation orders involving metals yet issued by WPB, is that asking thousands of manufacturing plants to stop using iron and steel in the manufacture of more than 400 common civilian products. These include such common items as bathtubs, pie plates, cash registers, waste-baskets, cigarette lighters, clock cases, mail boxes, and fountain pens. Limited production is allowed for 90 days after May 5, the date of the order.

WPB on May 7 prohibited the use of copper and its alloys, including brass and bronze, in an additional hundred-odd civilian products, the new ban applying May 31. A new list, A-1, has been added, some of the items being bulbs, neon, and fluorescent tubes for advertising; bulbs and cords for Christmas trees, dog collars, etc.

All domestic electric ranges in hands of manufacturers, distributors and retail dealers were frozen May 2 by WPB.

Diversion

Plans have been made to increase the output of structural steel shapes used in shipbuilding and curtail other items rolled in those mills. Production of shapes has not kept pace with plates.

WPB has diverted 255,000 tons of copper and 45,000 tons of zinc from frozen civilian goods lines to military uses—such items, perhaps only partially fabricated, as ash trays, door knobs and roofing.

Minutia and Trivia

Lawn mower manufacturers have been permitted by WPB to produce at full rate until June 30, 1942.

Use of brass screws or other copper products to attach handles to blades of saws is illegal. Steel screws are acceptable.

Rationing control over sales and transfers of new adult bicycles has been delegated to OPA. However, WPB retains control over the production of bicycles and their sale to defense agencies.

Shoemakers are asked not to use steel "nailheads" or brads to decorate uppers and "platforms" of women's shoes.

"Coat hangers freed from death sentence," states a headline. In other words, manufacture may proceed where the only metal is a steel wire hook.

Limitation order, L-77, on metal windows has been amended to permit manufacture of basement windows and residential-type casements for use in certain rated housing projects.

"Windblown for Victory" is the heading in the official weekly bulletin of OEM to describe the fact that WPB has restricted the amount of metal to be incorporated in hair pins and bobby pins and has regulated their length and thickness for metal conservation.

Manufacture of cutlery has been greatly curtailed by WPB, purpose being to save 6,000 tons of steel, including 2,000 tons of stainless, and 600 tons of copper alloy. Penknives and manicure implement manufacture is to cease altogether, though utensils involving food will enjoy limited output.

Prices and Price Ceilings

While the average level of wholesale prices has risen 30 per cent since September, 1939, the composite of steel prices is up less than 1 per cent, stated Walter S. Tower.

Contrary to the long-talked-of inflationary tendencies has come a minor wave of price reductions among the metals. One of the latest is iridium which was reduced $10 a troy ounce to $165.

Reductions in prices of fabricated aluminum products, previously scheduled by OPA to take effect June 15, have been postponed to July 1, 1942.

Maximum prices for non-ferrous foundry products have been based on levels prevailing between Oct. 1 and 15, 1941.

Higher maximum prices on certain lighter weights of relaying rail have been allowed.

Maximum prices for rolled zinc products were announced April 30 by OPA, these being prices announced Nov. 29, 1941.

Maximum prices for standard ferromanganese were fixed April 30 by OPA.

Formal price ceilings for fluorspar at levels generally prevailing on Jan. 2, 1942 have been set by OPA.

Junk Will Beat Hitler's Bunk

Despite considerable publicity on metal salvage programs announced by WPB, the fact is that no overall control has been made to date.

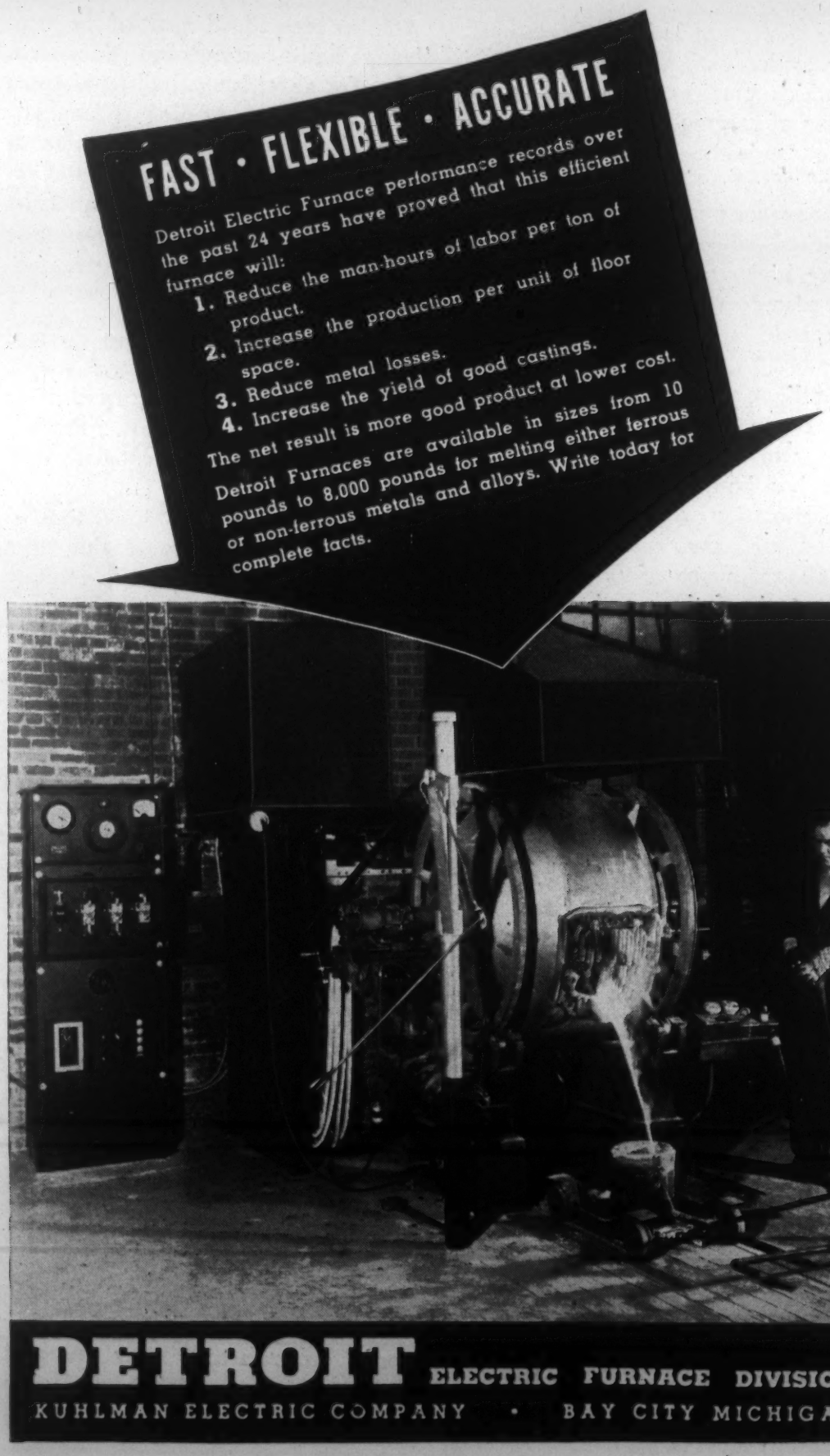
Public confidence was chilled when the household aluminum "pots and pans" drive was made, because WPB had made no plans to either collect and segregate, or to ship and melt the metal. OPM, WPB's predecessor, failed to get along with organized scrap dealer groups, and Leon Henderson's ceilings have bottlenecked some of the flow back to the mills. Well informed metals men—largely not in Government employ—believe that scrap prices should be based on f.o.b. junk yards.

WPB's Bureau of Industrial Conservation has been headlined in newspapers for a number of projects, all rather loosely related:

Pride of the Gay 90's Is Wrecked

It induced the Metals Reserve Co. of RFC to buy the abandoned New York, Westchester and Boston Railroad for its 15,000 tons of rails, steel, and miscellaneous scrap, for $423,600 —averaging $28.24 a ton. This included more than 100 tons of copper, 96,000 ft. of lead covered cable, and 241 electrical transformers.

Several moves have been made to



advance the demolition of New York City's last remaining elevated structures.

Three thousand tons of rail are being ripped up in Queens, New York.

The Bureau's "auto graveyard" section is beginning to get cooperation of junk dealers. A steel company in Rochester, N. Y., melted six whole junked cars (sans engine, transmission, rear axle, upholstery, glass, radiator, wiring, etc.) as a demonstration of simplifying the break-up process. Metallurgists are analyzing the melt.

Scores of buildings are being torn down to salvage scrap.

The Army has agreed to cut up more than 250 obsolete tanks and ship the scrap to steel mills.

A steel company estimates that huge tonnages of scrap can be had from steel mill dumps consisting of such waste as "skulls," where molten metal overflowed ladles, scrap ordinarily not worth recovering.

Personnel Changes at Capitol

A. I. Henderson succeeds William L. Batt as Director of Materials of the War Production Board to allow Mr. Batt to devote more time to his other war activities. Mr. Henderson, a New York attorney, had been Mr. Batt's deputy director.

Tall and husky, Mr. Henderson has been described as one of Washington's tough-minded thinkers. A captain in the AEF during the first World War, he has more recently led his department through barrages of conservatism, red tape and opposition to quite considerable accomplishments.

Mr. Batt still has plenty of irons in the fire, being chairman of the top Requirements committee, American representative on the British-American Combined Raw Materials Board, chairman of the U. S.-Canada Coordinating Committee and coordinator of the Russian aid program.

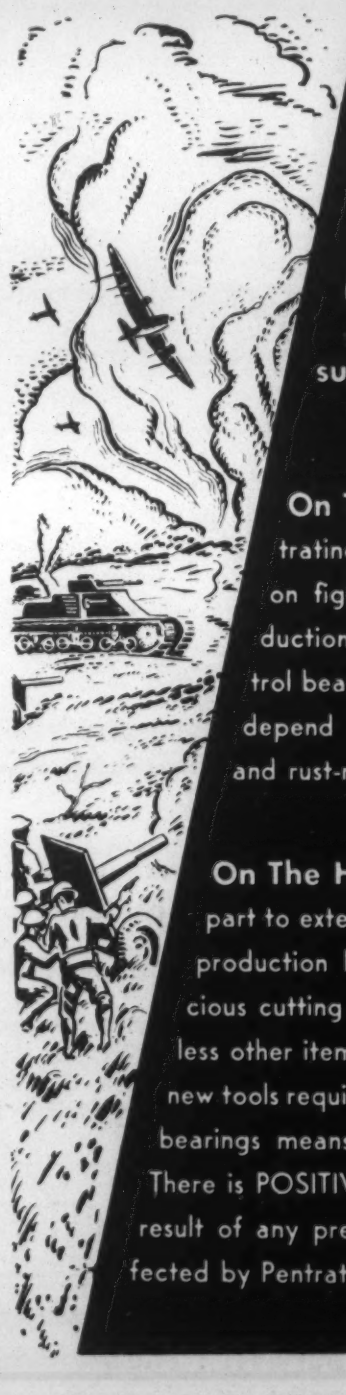
A fourth chief of the iron and steel branch, WPB, is now in the saddle, Reese Taylor, former president of Union Oil Co., Los Angeles, in place of C. E. Adams, who resigned recently because of ill health. Besides Mr. Adams, his predecessors have been A. D. Whiteside and Walter S. Tower. Mr. Taylor's steel experience comes, at least partly, from the Consolidated Steel Co., of which company he was for several years president.

George C. Heikes will succeed D. A. Vebalacker as chief of the Zinc Branch, WPB, effective July 1, having previously been his assistant. Mr. Heikes is a geologist and for several years was with the National Lead Co.

Charles F. Willis, state secretary of the Arizona Small Mine Operators Assn. and chairman of the board of governors of Arizona Department of Mineral Resources, has been appointed consultant to the Metals Reserve Co., which is the government ore and metals buying agency.

Now that you've read this new department through to the end—we hope—why not drop us a line indicating how you like it? We'll be grateful.

A MODERN STEEL FINISH *fights* A MODERN WAR



PHYTANIUM-BLENDED

PATENTED *Pentrate*

supplies that needed "shot-in-the-arm" to critical steel supplies

On The Battle Front . . . This deep black penetrating finish is protecting steel propellor blades on fighting planes, its durability and friction reduction qualities lend valuable properties to control bearings and precision parts. Embattled forces depend on Pentrated surfaces for smooth action and rust-resistance on all types of firearms.

On The Home Front . . . Pentrate is doing its part to extend threatened steel supplies. Increased production life is Pentrate's contribution to precious cutting tools, taps, dies, gauges, and countless other items. More pieces per grind means less new tools required. Longer life of dies, gauges, and bearings means advanced production schedules. There is POSITIVELY NO SIZE CHANGE and the result of any previous treatment is in no way affected by Pentrate.

This attractive Black finish is replacing strategic metallic finishes on millions of non-defense items, too. Low in cost and simple to operate, the Pentrate Process can be quickly fitted into any production line. Full information on request.

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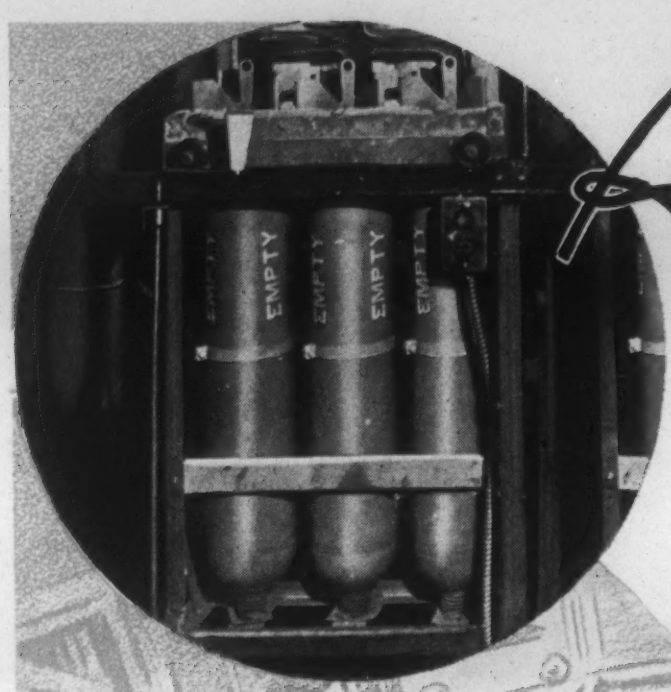
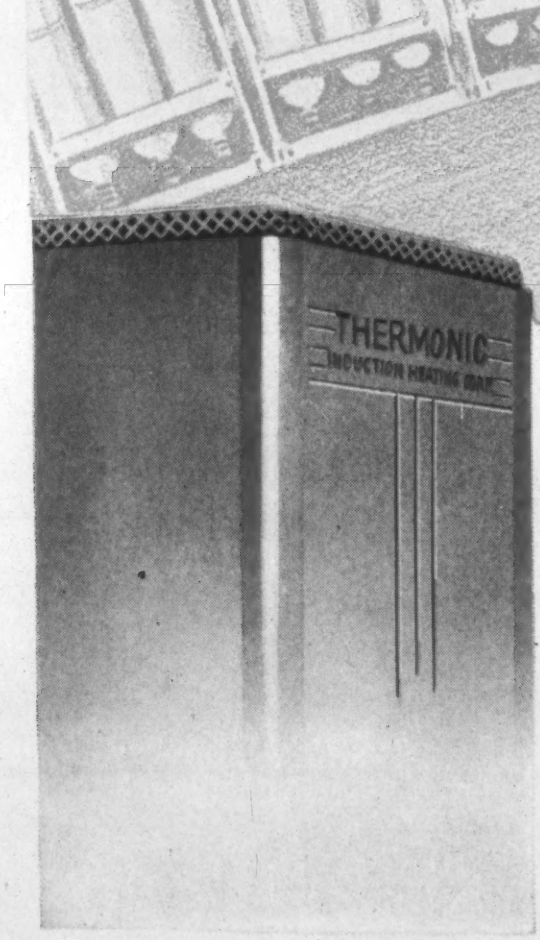
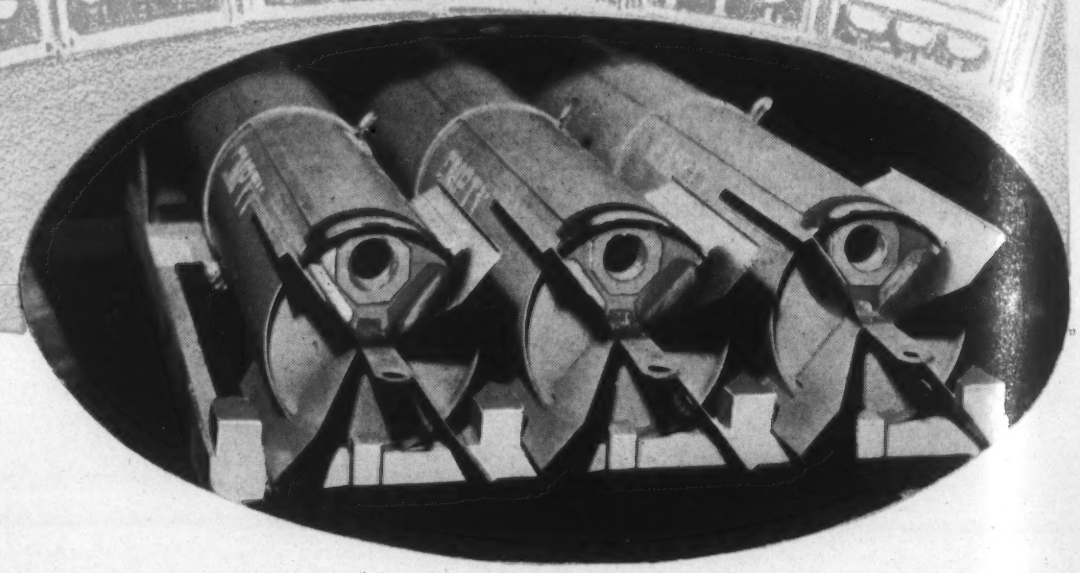


Another Difficult Problem

Solved by

Thermonic





A series of Data Sheets completely covering the subject of Induction Heating will be issued monthly. No. 1 is ready for you. Write to Department C.

The problem of brazing a ¾" threaded flange into a completely closed 20 gauge sheet steel container was solved by Induction Heating.

Inductors, energized from a Model 1070 Thermonic Induction Generator, were placed directly over the flange and caused heating of the flange and a small area of the sheet steel container.

With this process it was possible to perform three brazes simultaneously, in 35 seconds.

A pre-placed ring of Easy-Flo Silver Alloy melted and flowed to form a perfect, air-tight joint.

This is only one of the many problems solved by Thermonic in this "War for Survival". The same engineering staff that solved this problem are available to you.

INDUCTION HEATING CORPORATION

Designers • Builders • Of Thermonic Heat Treating Equipment

389 LAFAYETTE STREET, NEW YORK CITY, N. Y.

Feature Articles

Tractor Forgings

Few metal-forms can successfully challenge the position of forgings in the manufacture of modern munitions, and their speedy and efficient production is therefore of wide engineering concern. Chase (page 956) tells how one big tractor plant makes its forgings.

Silver Solders Containing Lithium

Silver solders are ideal for many jobs, and their utility has been further expanded by the tin scarcity. But add some lithium to the alloys, says Hensel, Larsen and Swazy (page 962), and you have a silver brazing alloy that is still better for certain jobs, particularly the joining of large sections.

Predicting Weld Hardening

The ability to predict, from its composition, the probable tendency of a steel to develop weld hardening and cracking should be a useful trick in these days of strange steels and widespread war-product welding. Edson (page 966) offers data and a chart that in intelligent hands can give just such information.

Anodic Coatings on Aluminum

We've heard a lot about "stretching" our available aluminum supply to get just so many more airplanes and engines out of it, so it's cheering to learn from Hill and Mason (page 972) that the widely-used anodic coatings on aluminum are surprisingly elastic.

Open Hearth Slag Control

Scott and Joseph (page 976) conclude their report on steelmaking slags and desulphurization, with some useful tables.

Wartime Conversion Problems

The "conversion" section this month concentrates on sheet-metal fabricating problems, with a "practical pointers" article by Campbell (page 980) on the manufacture of exhaust manifolds, and a pictorial presentation (page 981) on the making of aircraft oxygen cylinders.

Metallurgical Engineering Digests

Mineral Supplies of the Axis Today

The strategic position of the Axis and its ability to wage a long war have been considerably improved through new mineral supplies acquired by conquest to date, reports Pehrson (page 1014). So we've got to do more than just take comfort in our still preponderant position mineral-wise, and do it fast!

Powder Metallurgy

Great interest in the use of powder metallurgy fabrication for making parts faster or with less machining or with less raw materials is reflected in the large number (25) of recent articles reviewed in a composite digest on this subject, starting on page 1025.

Welding Stainless Steel

More information to add to that given in Campbell's "Conversion" article (page 980) on welding stainless steel is found in a composite digest on page 1034.

Engineers Wise—Metallize

Engineers wise will oft' metallize rather than throw away parts that are worn, which can be reborn with a little metal-spray. Let's war on waste! Why, you may be in haste and can hardly afford to wait to order them new—there's a tip for you by Cumming on 1038.

Munitions Heat Treating Furnaces

The important place gas-fired heat treating furnaces have taken in the production of projectiles and armament is discussed by Heyn (page 1042).

Steel-and-Wood Aircraft

In the post-war business melée, aluminum is generally expected to make the steel industry dig in and defend its long-held markets. But aluminum may itself face a threat from steel, it is hinted in an article on a new type of steel-and-wood aircraft in *Aero Digest* (page 1048).

Hardness Conversions for Cartridge Brass

A conversion table for Rockwell-Brinell-Vickers hardness units as applied to cartridge brass, prepared by Townsend for the A.S.T.M., is condensed on page 1078.

Weldon Tool Co. relies on Homo Tempering for its line of high-speed steel metal-working tools.

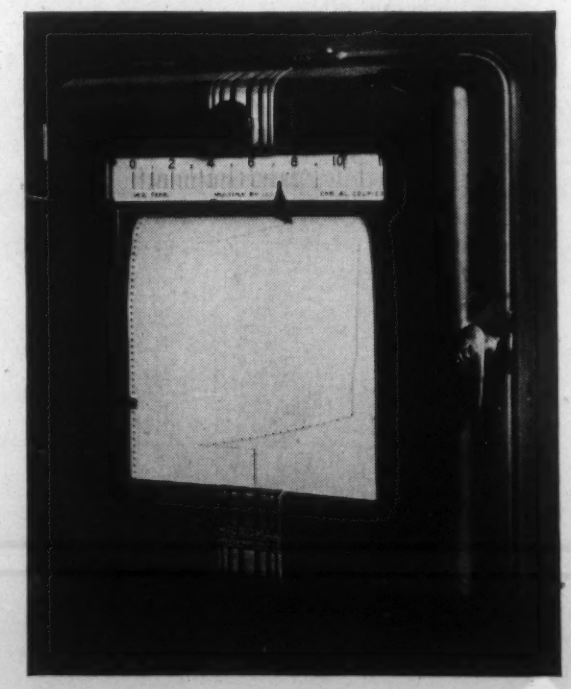
Assembly of airplane engines is requiring the use of thousands of Homo-tempered endmills, milling cutters, drills, etc.

War-Winning Work From Homo Furnaces!

Continuous-production tempering of drills, reamers, milling cutters and other tools for making airplane engines, rifles, ships, tanks—that's one of the war-time jobs of Homo Tempering Furnaces. The Homo shown above has been "taking it" for months on an all-out schedule of just that sort, tempering precision tools with never a reject—re-running entirely ended by the Homo Method's accuracy.

Low-Temperature Tempering

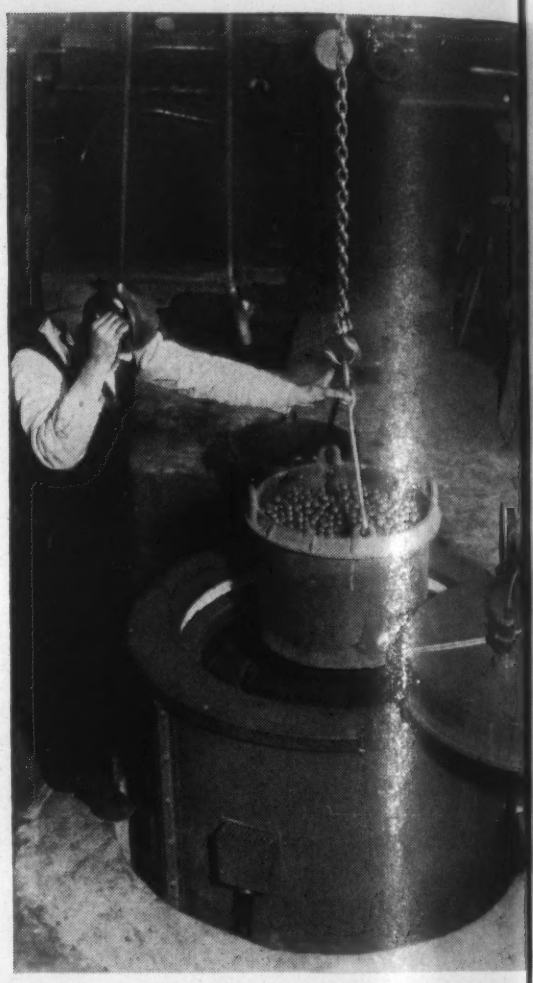
Stress-relief tempering at well below 300 F is another standard Homo task. Because of its high-speed, forced-convection heating, the Method is highly successful on dense loads of steel balls in the country's bearings plants, and it is also a prime favorite in tool rooms, where accurate tempering leads to longer life for badly-needed production tools.



Fully-automatic regulation of temperature is a prime Homo Method advantage. Here is a typical Controller.

Anneal of Forgings

Gun parts, gears, shafts and hundreds of other war-matériel forgings are annealed, at temperatures of 1300F and more, by the Homo Method. This is strenuous work; the parts bring much forging-scale to the Furnaces; the loads are heavy; the temperatures high. But the modern Homo takes them all in stride. Its scale-proof heater, heavy insulation, strong construction and fully-automatic control make it ideal for this duty.



If you have dense-packing parts to temper, and require the most extreme uniformity of temper, look into the Homo Method. Here it is being used on bearing balls, where requirements are particularly severe.

Furnace Engineering—Field & Office

Hardening, carburizing and nitriding, as well as tempering, are operations for which we have highly-perfected Methods. Our engineers have solved literally thousands of heat-treating problems, and their only duty, in this most critical of summers, is to find still more and solve them, as quickly as possible. If you face a heat-treating situation, either in your own plant or as adviser in another one, get in touch with us. Your communication, addressed to this office, will be sent to the nearest of our 15 branches, for prompt attention.

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Wartime Changes in our Staff

With mixed feelings we announce that our capable and energetic young assistant editor, Henry R. Clauser, has enlisted in the U. S. Army. He left METALS AND ALLOYS early in May, after playing the major part in preparing and editing the special "conversion" section that featured the May issue. His association with us of less than a year has demonstrated not only his editorial talent but his great ability to make friends. We all wish him "Godspeed."

At the same time we are happy to announce that Harold A. Knight has joined our staff as associate editor. Mr. Knight has a long and intensive record in business and engineering journalism, particularly in the metals field. A graduate of Cornell College in Iowa and also of the School of Journalism of Columbia University, his experience has included several years of editorial work on *The Iron Age,* the *New York Journal of Commerce* and *Steel*. In this work he has specialized on the news, markets, and general developments of the metal-working industries. He has written a number of special feature and other articles.

Mr. Knight brings to the staff of METALS AND ALLOYS a broad general background and valuable editorial experience in the metal-processing and metal-working field that will further strengthen the editorial content of this magazine.

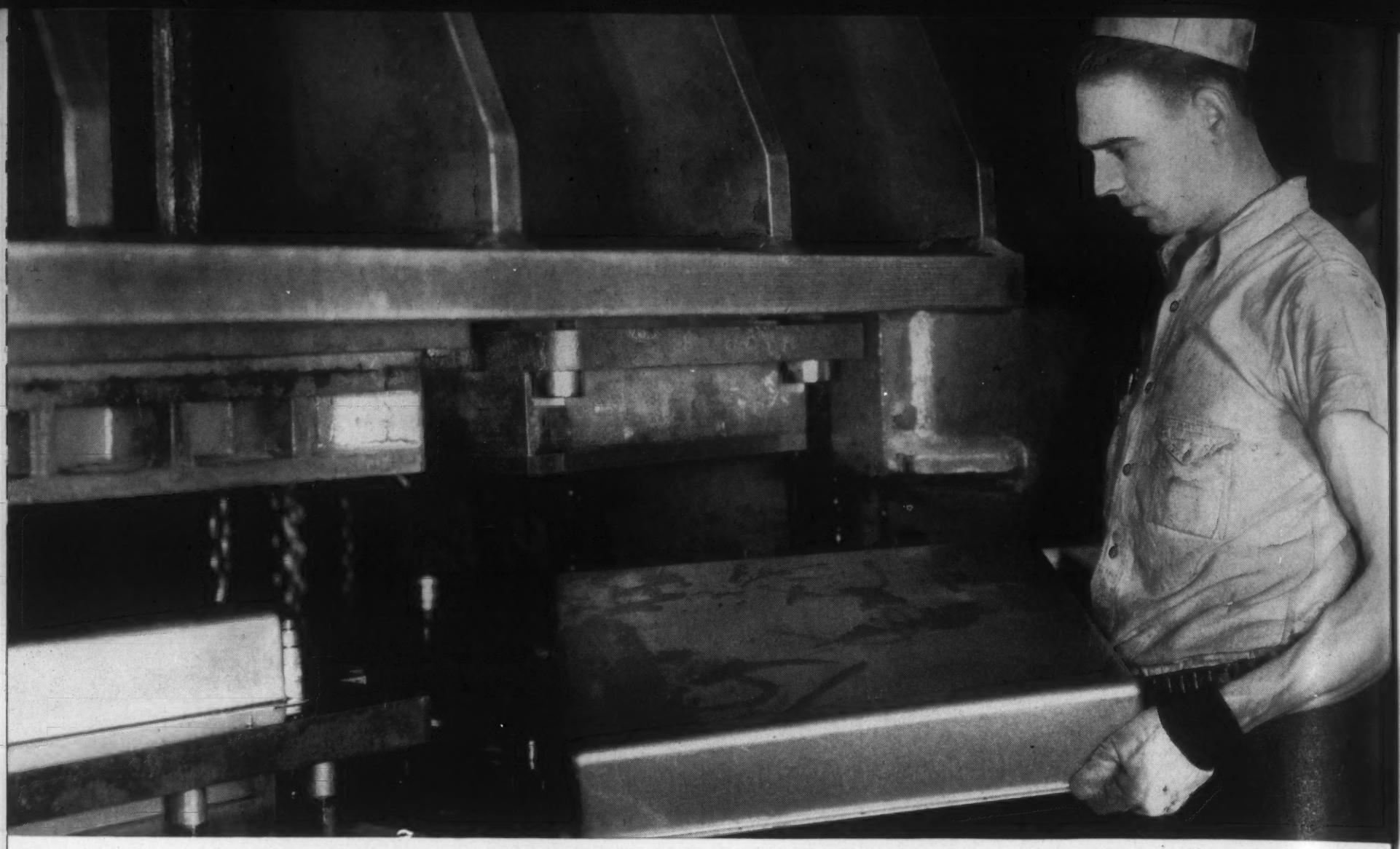
—The Editors

Concerning Pig Iron

For many years two leading trade papers in the steel industry have been collecting and publishing each month the production of coke blast furnaces. These pig iron, ferromanganese and other data are of great value to the industry. This has been stopped by the censorship on the ground, we are told, that this information furnishes a measure of our steel output. The data are assembled now by the American Iron and Steel Institute, but are confidential.

And yet, despite this unusual order by the censors, the Institute continues to publish at least monthly and usually each week, the country's volume of steel ingot production.

The quantity of pig iron made is not a measure of this country's steel output. Scrap



Stress cracking is overcome in the above refrigerator door pan by mounting both the draw and trim dies in the same press, cutting to seconds the lapsed time between draw and trim.

How to Prevent Stress Cracking

Losses due to "spontaneous" cracking of severely drawn, or cold worked mild steel and iron are troublesome, particularly now when maximum war production demands economy of steel and the greatest possible number of usable parts made in the shortest possible time.

Cracking, or splitting, occurs after the draw operation, often when the parts are finished and placed in stock. The causes of failure are the severe strains in the metal and age hardening resulting from cold working. Work hardening in corner draws has been known to increase hardness from Rockwell B-40 in the blank to Rockwell B-81 in one particular type of pan.

To prevent stress cracking, start with a steel suitable for the job. Avoid extreme changes of temperature, such as storage of parts in cold areas. If equipment is available, relieve stresses by annealing soon after the drawing operation, or trim immediately after drawing before the metal age-hardens and loses much of its ductility. Cracking has been eliminated by reducing the lapsed time between draw and trim from hours to seconds. In some instances draw dies and trim dies can be assembled in the same press thereby cutting lapsed time to the minimum by permitting a draw and a trim at each press stroke.

Inland metallurgists have helped many manufacturers use steel economically to speed up war production. They are ready to help you.

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and iron ore are more and more a factor in the open-hearth charges and all electric steel is made from scrap.

Unless there is some other reason for this order, the decision is at least unexplainable.

●

One of the committees of a large specification making organization of the country is virtually stalled on the writing of specifications for pig iron. This is due largely to conflicting consumer and producer interests. Present operating conditions contribute decidedly to this situation. Due perhaps to the character of the scrap situation and possibly to that of certain raw materials, some of the pig iron being produced and sent to consumers runs very high in arsenic, and contains other elements such as copper in objectionable proportions. Rejections of car loads containing impurities or allowing elements in objectionable proportions are reported. In some cases the arsenic is reported as high as 0.25 to 0.70 per cent.

Possibly a specification which would limit the composition of the pig iron produced would ameliorate the situation — if consumer and producer interests could be reconciled. But manifestly more care in the segregation and selection of scrap and raw materials would be both helpful and wise.

●

From time to time statements from various sources have appeared on the air conditioning of blast furnaces. The gist of these has been that already three companies have adopted this expedient and that others are seriously considering it. Operation of furnaces thus equipped have not been of long enough duration to draw definite conclusions but the trend is established that the production of an air conditioned furnace is increased — perhaps from 5 to 8 per cent.

Other methods of expanding pig iron output include—the washing and cleaning of coal to remove harmful sulphur and ash before conversion into coke, the grading of coke for size since it is claimed that some kinds of ore yield more pig iron when a particular size of coke is used, and the operation of blast furnaces at higher temperatures than usual.

These developments are of prime importance in present circumstances — the shortage of scrap and pig iron. To insure capacity output of steel furnaces, any or all of these methods should be investigated and adopted wherever possible.

—E.F.C.

Converter Steel

Eradicating a false impression is difficult enough, but eradicating it once it gets into specifications is like cleaning the Augean stables. We find it hard to forgive the "salesmen" who built up the fiction that electric furnace steel is necessarily quality steel and that converter steel is necessarily punk steel. This never did jibe with the facts; given hot metal of proper composition for the converter and with modern methods of desulphurization, much of the earlier difficulty is avoided.

In the steel castings field, one of our West Coast Navy Yards has supplied converter steel castings for Navy repairs for many years with highly satisfactory results, yet many Government specifications do not admit converter steel, no matter how far the properties of test specimens representing castings outstrip the requirements of the specification.

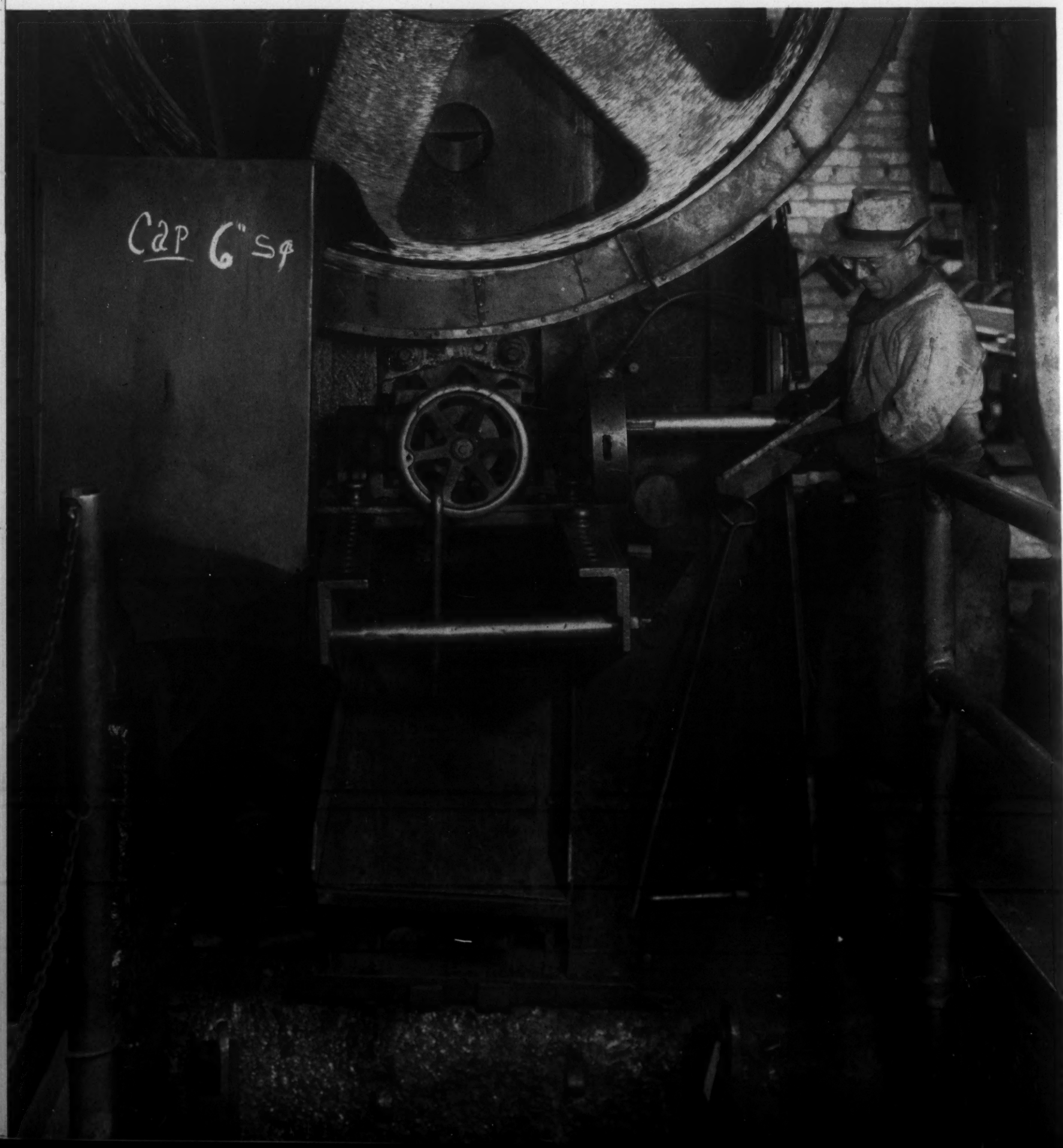
In wrought steel, a similar situation holds, with the alleged reason, in both cast and wrought, that converter steel is deficient in low-temperature toughness. For many uses of wrought steel, rimmed converter steel is adequate, and if such steel be tested in notched impact at low temperature, it is characteristically low-temperature brittle, but scarcely more so than other types of coarse grained rimmed steel. Proper killing that produces fine

(Continued on page 988)

Making Tractor Forgings

by HERBERT CHASE

One of four heavy shears used for cutting bar stock into billets to be forged. Billets are dropped from the chute and fall into tote boxes in a pit below, avoiding unnecessary handling. The machine shown is of 6-in. square capacity.



On the war production front the speedy and efficient manufacture of high quality forgings stands out as one of the most important "actions." It is therefore timely and helpful—in view of the vastly increased use of forging in the last year—to have this article on hammer-forging and press-forging practice in the modernized forge shop of a large manufacturer of tractors (and many other things as well, today).

The article incidentally provides much evidence that modern manufacture of high-quality forgings depends on careful attention not only to the forging operation itself, but to the prior and supplementary processes—preparation of stock, heating, trimming, normalizing, cleaning, etc. —*The Editors*

THE WIDE EXTENT to which forging operations can be improved by revamping of existing facilities is clearly illustrated at the Tractor Works of the International Harvester Co. in Chicago. Recently the forging department has been entirely rearranged. New and more modern forging equipment and specially designed furnaces as well as other devices of the most modern variety have been installed.

This department, which occupies a building 500 ft. long and 120 ft. wide, now operates 30 steam hammers ranging from 800 to 12,000 lb. capacity, three board drop hammers, three upsetters, a forging press and supplementary equipment of the latest design. In many instances the old box-type furnace used for heating steel billets has given place to new continuous production furnaces of the pusher type. Some of the latter feature magazine feeds, while others are equipped with conveyors, which pick up the hot billets as they are automatically discharged and deliver them to adjacent hammers as rapidly as the forging operation can be performed. In addition to these, there are many heat-treating furnaces throughout the department, some electric and some gas-fired.

Heating Furnaces with Automatic Control

All billet heating furnaces are equipped with automatic controls for both the low pressure air and fuel. Products of combustion or waste gases escape through stacks near the charging end, the flow of gases being counter to that of the billets in the furnace, which are heated gradually and with minimum scaling. Very little flame escapes at the discharge end and none at all from furnaces equipped for automatic discharge of billets. In the latter the heated billets fall through a slot in the furnace floor and then down a chute through a light, hinged, gravity closing door onto a conveyor. The discharge chute is above a pit from which the ascending conveyor delivers the hot billets to a station from which the hammerman may easily pick them off with tongs as required. The

A pair of continuous pusher furnaces designed for automatic discharge of heated billets onto inclined conveyors which elevate the billets to a point where they are picked up by hammermen at right and left. Billets drop through hinged doors which close by gravity. There is no flame and no significant escape of gas or intake of air at the discharge end of the furnaces. The billets shown are used in the production of track links.

rate of discharge can be adjusted to equal the rate of forging so that, as one forging is finished, a billet for the next is available at the top of the conveyor.

Furnaces are so placed as to discharge heated billets as close as practicable to the forging hammer. The furnaces are well insulated throughout so that there is a minimum loss of heat. This not only results in a more comfortable working condition, but also in greater fuel economy and introduces appreciable economies in the consumption of fuel. As the maximum temperature desired is never exceeded, furnace maintenance is minimized and uniform temperature of billets is assured.

Between 85 and 90 per cent of the 125 tons of forgings produced per 24-hr. day are heated in pusher furnaces with automatic temperature control. Forgings range in weight from 4 oz. to 100 lb. each, and some 30,000 forgings constitute an average day's output.

Every consideration is given to the safety and working condition of the employe. Among the effective safety features used in combination with hammers are scale guards on the side opposite to that on which the hammerman works. Roll-up doors all around the building aid in good ventilation.

Bar stock to be forged is stored in a yard adjacent to the shop. From there it is transported to stock racks by a crane. In the case of "high" alloys, the bars are first heated to a temperature of 400 to 600 deg. F. in an open pit furnace to avoid fractures in shearing. Low carbon and some alloy steel is sheared

Forging a connecting rod on a steam drop hammer. The forging is immediately transferred to the trimming press, trimmed and then hot coined by a second operator.

Defense forging being made on a 12,000-lb. hammer. Helper at left uses a steam jet to blow scale from deep impression die.

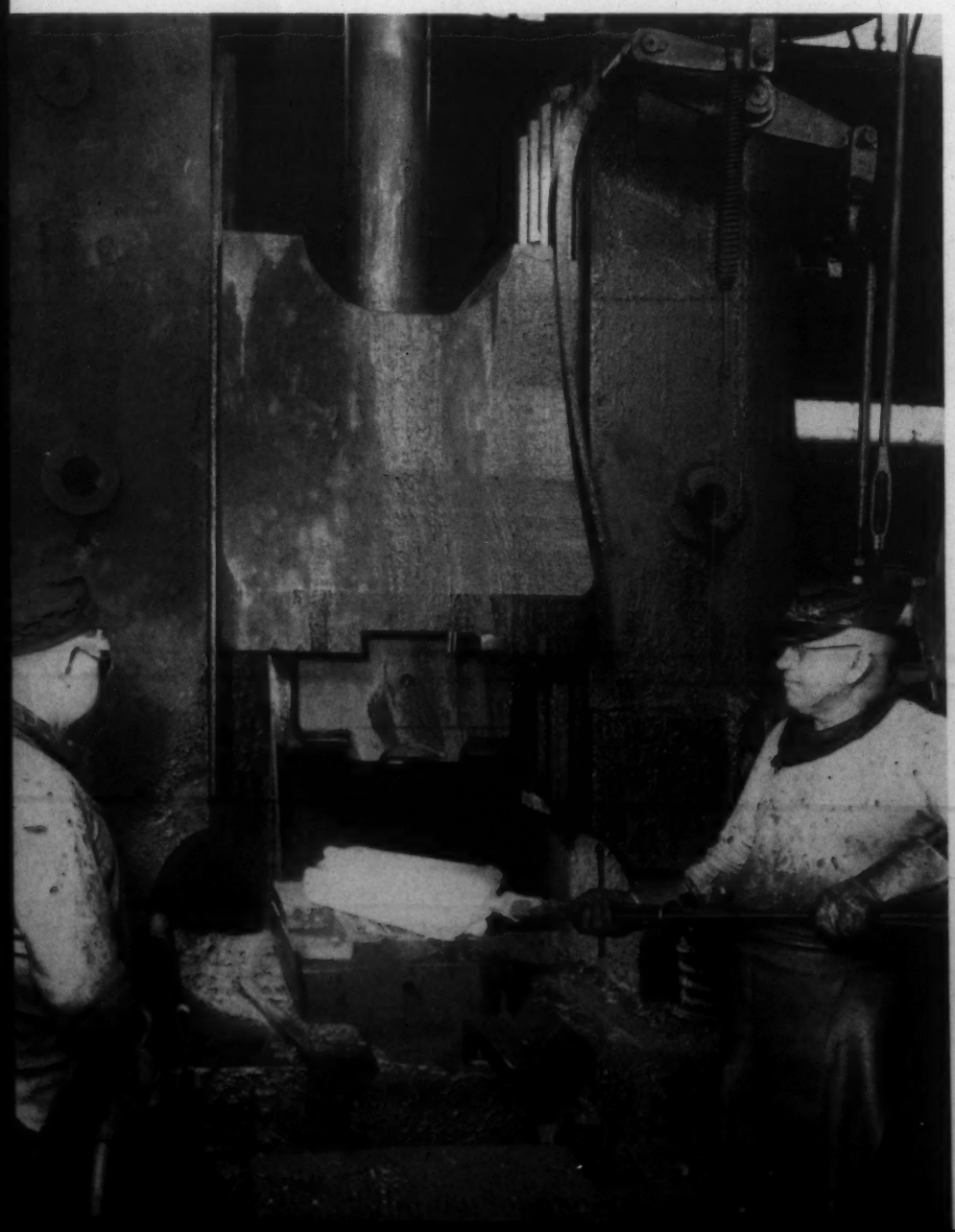
cold. Four shears ranging upward to 6 in. sq. capacity cut steel 24 hr. a day. At the back of each shear is a long pit for the reception of billets cut off by the machine. The floors of the pits and their adjoining stalls are equipped with roller conveyors on to which tote boxes are lowered by the overhead cranes which span the shop. Cut billets from the shears fall into the tote boxes through a chute, thereby eliminating manual labor in loading the boxes. When filled, they are carried by the crane to points near the hammers and are then transferred by truck to points at which furnaces are loaded.

Links for the "TracTracTor"

Forgings required in exceedingly large quantities are links for the crawler type tractor, or TracTracTor. They are made in hammers from 3,000 to 4,000-lb. capacity. These forgings are made from flat stock, the slabs weighing 5½ to 15 lb. each, the entire forging being made in two to four blows of the hammer. After forging the piece is trimmed, punched and hot coined in a press, normalized and cooled in air.

An unusual forging made in considerable quantities is a double-flanged track roller. The roller is

First step in forging a double-flanged track roller, one flange and the hub of which are seen already formed. After trimming flash and punching the hole, the forging is placed in a second die having a split collar and the second flange is formed.



forged from a 31-lb. billet. The forging heat of 2,200 deg. F. is obtained in a continuous furnace, with the first forging operation being done in a 5,000-lb. hammer. This operation forms the piece to the shape (without the second flange) as shown in one illustration. After being trimmed and the holes punched in a single operation, the forging is placed in a second die. A split ring is inserted into a recess in the die around the forging, thereby preparing the die for the second or upper flange to be formed. The center hole of the forging is hot punched. This method produces a draft-free surface between the flanges and a closely controlled diameter. After the forging has been normalized and shot blasted, the hubs of two such forgings are flash-welded together in a machine set up for this purpose. After normalizing the weld, the forging is delivered to the machine shop.

Forging and Heat Treating Crankshafts

The largest forgings produced in the plant are crankshafts for 4-cylinder tractor engines, a typical one requiring a 100-lb. billet of 3⅝ in. round corner square steel stock. Billets are heated in a continuous pusher furnace and forged in a 12,000-lb. steam hammer. The first operation is "rolling" to prepare the sectional volumes of the cranks. Next, the forging is "broken down" to the approximate contour it ultimately assumes. After that it is finish forged and transferred to a trimming press where the flash is removed. The forging, still hot, is then delivered to an upsetter, which grips the main body of the forging while a flange is being formed on one end. The finished forging is finally placed on a rack and allowed to cool to room temperature.

Normalizing of the crankshaft follows, this being done in an automatic electric furnace. Immediately after the forging is discharged it is placed while still hot in a quick-acting hydraulic press to remove any distortion and to maintain certain specified dimensions. Then the forging is hung on an overhead conveyor which carries it through an air blast—to give a rapid air quench—and then is allowed to cool slowly to room temperature.

The machine used for cleaning crankshafts is of special design. It is equipped with live rolls for rotating the forging slowly, so that all surfaces are exposed to the shot blast employed. The rolls are mounted on a reciprocating carriage which automatically stops at one end of the machine for loading and unloading, the carriage advancing the work through the shot blast and automatically returning to the loading position. Smaller forgings are loaded into a separate drumtumbled type machine in which they are turned during the blasting operation. Blasting has done away with pickling formerly used for scale removal, thereby creating more pleasant and healthful

Crankshaft as it appears after drop forging in 12,000 lb. hammer. Flash is trimmed in an adjacent press.

Before cooling appre ciably, the trimme crankshaft forging placed in this upsette and the flange at the f end is upset, all bein done in one heat.

After normalizing in an electric furnace, the crankshaft is sized and straightened hot by squeezing in a die in this fast-traverse hydraulic press.

working conditions. All blasting is done completely on the inside of thoroughly ventilated machines, eliminating the dust nuisance.

Producing Gear Blanks

Numerous gear blanks are among the many types of forgings cold coined and cleaned after forging. Such blanks require a minimum amount of machining. They are forged from billets of the proper diameter set vertically in the die to produce the desired grain structure in the blank. Gear blanks are nearly always punched and trimmed in a single operation, the punch producing a straight hole, (which makes drilling unnecessary) while external draft is also removed in this trimming die. The great strides made in the reduction of excess metal on forgings to be removed in machining are nowhere better illustrated than in the manufacture of these gear blanks.

One of the latest pieces of equipment installed in the forging department is a 2,000-ton forging press. This press is especially well suited for producing gear blanks, although it is by no means to be considered a single-purpose machine. Dies are not subject to the shock imposed by a hammer, and much smaller dies can be used. When made in circular blocks to fit the standard holder provided, such dies require very little set up time. As shown in one illustration, the holder has space for three dies, but a gear blank, such as one produced from a 3-in. cylindrical billet 4½-in. long, can be completed in each working stroke of the press, using only two simple dies. Impressions (for producing a gear blank) in the first die are recesses having the shape of a frustum of a cone, designed to control the flow of the metal, and to break the usual scale. The second die in turn shapes the gear. The forgings are accurately sized, and the grain structure is excellent. One piece is formed and a second is finished at a single stroke of the press.

Other details of the practices followed in this plant might be included if space permitted, but from the foregoing it is clear that the practices followed promote economy and a smooth flow of production, besides providing desirable working conditions. The whole layout and arrangement of equipment reflects credit upon those responsible for it and is an indication that forging practice is keeping step with the rapid advancement being made in other branches of the American metal-working industries.

Forging gear blanks in a 2,000-ton forging press which produces a squeezing rather than a hammering action. A billet is seen in the die at the left and a finished forging is held by the operator. In the third position is a blank die, as no third operation is needed for this forging.

Equipment in which forgings are cleaned by blasting. Smaller forgings are tumbled while being blasted in the machine at the left. Crankshafts are blasted while turning slowly on rolls in the machine in the background. Both machines are shown open, in loading position.

A Lithium-Bearing Silver Solder

by F. R. HENSEL, E. I. LARSEN and E. F. SWAZY

P. R. Mallory & Co., Inc., Indianapolis, Ind.

No small factor in the currently extensive use of brazing as a fast-production method of joining similar and dissimilar ferrous or non-ferrous metals has been the availability and highly dependable performance of the silver brazing alloys, popularly known as "silver solders." Still further improvement in the joint strength and flow properties of these materials is reported in this article as achieved through the incorporation of a small percentage of lithium in the composition. Actual brazing tests indicate the new lithium-bearing silver solders to be broadly useful for joining a variety of metals, and to be specially advantageous for the brazing of large sections.

—The Editors.

THE SILVER BRAZING of comparatively large sections of tungsten-copper contact materials (Elkonite, previously described in detail by these authors—"Tungsten-Copper for Electrical Contacts"—METALS AND ALLOYS, May, 1941.) containing a high percentage of tungsten, to certain backing materials is difficult, since this type of refractory contact material has a tendency to oxidize rather rapidly during the brazing operation. Furthermore, it is difficult to obtain proper wetting action of the refractory-metal particles, because tungsten does not alloy readily with the elements commonly used in the compositions of silver solders. The need for an improved silver solder for this particular class of material prompted an investigation which resulted in the successful development of a lithium-bearing silver solder for that purpose. (U. S. Patent No. 2,235,634—F. R. Hensel, K. L. Emmert, J. W. Wiggs.) The present article contains the results of tests with this brazing alloy for joining ferrous and non-ferrous alloys.

Preliminary Work on Contact Materials

A preliminary series of tests was made with a standard silver solder, to which was added various percentages of lithium. The compositions of the three experimental silver solders, and also the melting points and flow points, are given in Table I.

The brazing alloys were used in conjunction with a small amount of fluxing material.

The test materials to be brazed were copper and a tungsten-copper Elkonite containing approximately 70 per cent W. The dimensions of the pieces were 5/8 by 5/8 by 2 in. The pieces were butt brazed and then subjected to a cross breaking strength test. This test consisted in applying the load to a brazed section with the fulcrum at the point of the brazed joint. The brazed specimen was supported on both ends by round supports, 1½ in. apart. The brazed joint was equidistant between the two round supports; thus the entire load was applied to the brazed joint. In such a test, the fibre directly under the load was in compression, whereas the outer fibres of the bar on the opposite side are in tension. The test pieces were prepared as follows:

1. The brazing surface of each metal was thoroughly cleaned by grinding.

2. The brazing surfaces were coated with a thin film of liquid flux applied with a brush.

3. A coupon of silver solder 0.005 in. thick, having approximately the same area as the test piece, was placed on the bar to be tinned.

4. The test specimen was then heated rapidly with an oxyacetylene torch until the silver solder melted and completely covered the brazing face. During the "tinning" operation it was noted that both silver solder B and C flowed more quickly and easily on the copper and the tungsten-copper Elkonite than did the solder A, which does not contain lithium. The ease of flow was particularly apparent on the tungsten-copper Elkonite.

5. The "tinned" sections of the test pieces were again coated with a thin film of flux and butted together under pressure. The assembly was then heated with an oxyacetylene torch to a temperature sufficiently high to cause the solder to melt. Sufficient pressure was exerted to squeeze out all the flux and excess brazing alloy. After the brazing alloy was molten, the heating was discontinued and the brazed joint allowed to cool through the solidification of the silver solder, after which the pressure was released and the specimen was allowed to air cool.

6. The specimens were then machined to 5/8 in. sq.

Table I.—Compositions, melting points and flow points of standard and lithium-bearing silver solders.

Type of Silver Solder	Composition, Per Cent				Melting Point deg. F.	Flow Point deg. F.
	Silver	Copper	Zinc	Lithium		
A	65.00	20.00	15.00	...	1283	1330
B	65.40	19.50	15.01	0.12	1281	1310
C	65.34	19.66	14.73	0.26	1279	1310

The cross breaking strength values of the specimens are recorded in Table II.

The results in Table II indicate that the brazed joints made with lithium-bearing silver solders have a higher cross breaking strength than the silver solder not containing lithium. It is further indicated that a lithium content of 0.12 weight per cent is superior to the higher lithium content of 0.26 weight per cent for this particular grade of solder. The test results also indicate that not only higher cross breaking strength values were obtained, but that the uniformity of the brazed joints is superior with lithium bearing alloys.

Table II.—Cross breaking strength of joints of copper and tungsten-copper (Elkonite) made with lithium-free and lithium-bearing solders.

Type of Silver Solder	*Test No.*	*Cross Breaking Strength, lbs. per sq. in.*	*Location of Fracture*
A	1	50,900	Fractured partly in the copper.
	2	39,000	Fractured in the solder.
	3	37,200	Fractured in the solder
B	1	69,300	Fractured in the tungsten-copper.
	2	84,200	Fractured in the tungsten-copper.
	3	74,200	Fractured in the copper.
C	1	66,800	Fractured in the tungsten-copper.
	2	57,500	Fractured in the tungsten-copper.
	3	63,300	Fractured in the tungsten-copper.

Comparative Performance in General Brazing

In view of the results obtained on joining tungsten-copper Elkonite to copper with the lithium-bearing silver solder, tests were carried out using the silver solders A and B for the joining of nickel, stainless steel, Monel and S.A.E. 1010 steel, to each other. The same brazing procedure as described above was used. The pressure applied in this series of tests was 100 lbs. per sq. in., during the brazing operation. Both the tensile strength and the cross breaking strength were determined. The results obtained on tensile test specimens of the design shown in Fig. 1 and cross breaking test specimens of the design shown in Fig. 2, are listed in Table III.

In all cases, silver solder B tinned the test metals more easily and quickly than silver solder A. This was particularly true in the case of Monel and stainless steel. It should be noted in particular that the actual strength values for the B alloy fall within a narrow range. This indicates consistently strong and uniform joints.

Joint Strength and Film Thickness

To determine the effect of the thickness of the solder film on the strength of the joint, tensile test

Table III.—Strengths of joints in various metals brazed with lithium-bearing and lithium-free silver solders.

Base metal	*Type of silver solder*	*Tensile strength lbs. per sq. in.*	*Crossbreaking strength, lbs. per sq. in. (1-½-in. bridge)*	*Tensile strength, lbs. per sq. in.*	*Crossbreaking strength, lbs. per sq. in.*
Nickel	B	49,700	116,350	49,560	111,080
Nickel	B	51,000	104,300	—	—
Nickel	B	58,000	112,600	—	—
Nickel	A	33,000	76,300	37,730	77,400
Nickel	A	39,200	84,450	—	—
Nickel	A	41,000	71,500	—	—
Stainless Steel (18-8)	B	31,300	94,300	32,400	93,300
	B	33,500	92,400	—	—
(18-8)	A	30,350	98,400	29,400	86,400
(18-8)	A	28,500	83,500	—	—
Monel Metal	B	49,000	115,000	50,050	112,750
Monel Metal	B	51,110	109,350	—	—
Monel Metal	A	36,000	78,200	37,650	83,800
Monel Metal	A	39,300	89,500	—	—
C.R. Steel (S.A.E.-1010)	B	48,200	84,300	47,900	84,100
	B	47,600	83,900	—	—
C.R. Steel (S.A.E.-1010)	A	42,400	74,000	39,300	75,600
	A	36,200	77,200	—	—

Pressure on all samples ..... 100 lbs. per sq. in.

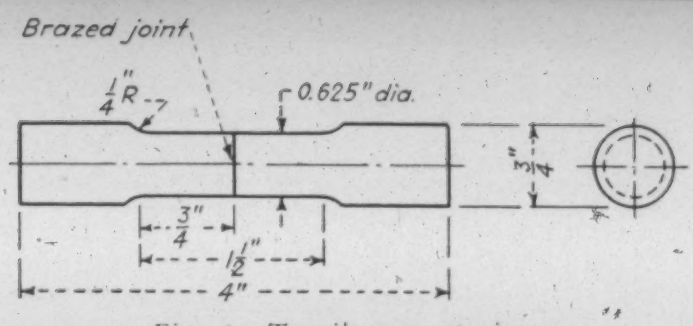


Fig. 1. Tensile test specimen.

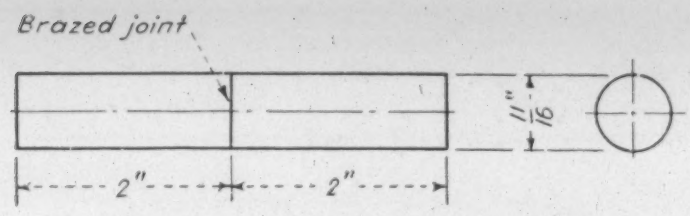


Fig. 2. Cross-breaking test specimen.

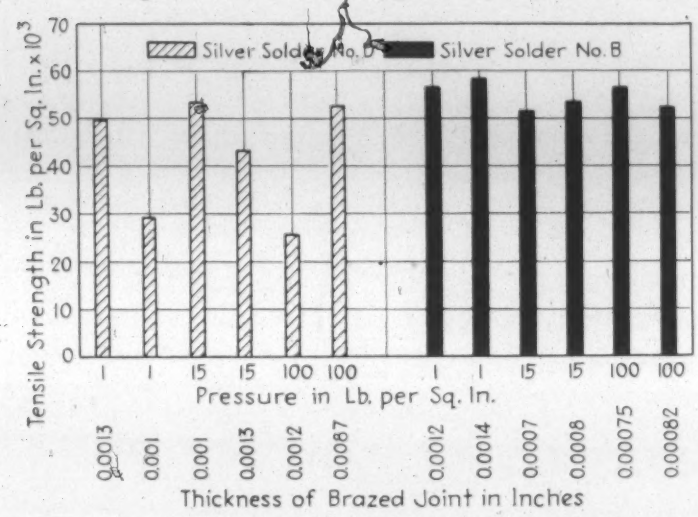


Fig. 3. Tensile strength of brazed joint; 18 and 8 stainless steel brazed to 18 and 8 stainless steel. Not pre-tinned.

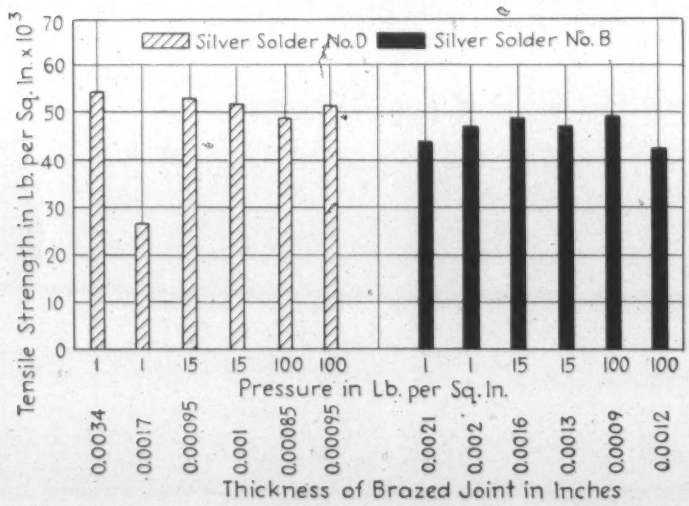


Fig. 4. Tensile strength of brazed joint; S.A.E. 1010 steel brazed to S.A.E. 1010 steel. Not pre-tinned.

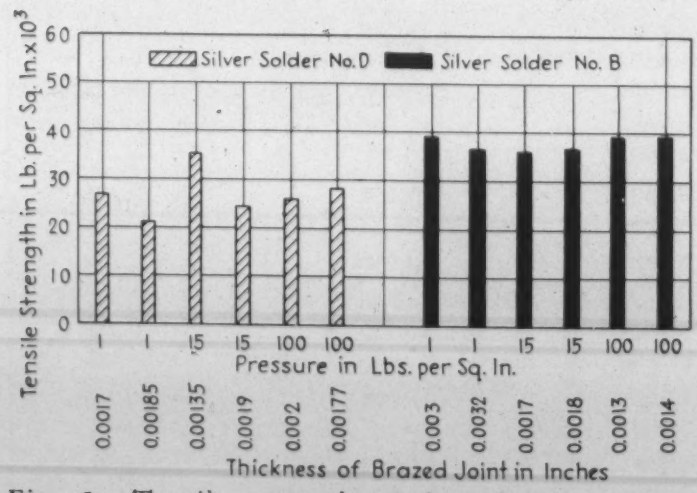


Fig. 5. Tensile strength of brazed joint; copper brazed to copper. Not pre-tinned.

specimens of cold rolled steel (S.A.E. 1010) were brazed. The applied pressures were varied to produce silver solder films of varying thicknesses. In other respects, the brazing procedure was identical with that heretofore described.

The machined specimens were etched with 5 per cent nital solution and the thickness of the solder films measured microscopically with a graduated eyepiece. The results are given in Table IV.

Table IV indicates that the strength reaches a maximum at 0.0015 in. thickness of silver solder film and decreases as the thickness of the film increases.

Silver Solders Compared

Comparative tests were made with a low melting point silver-copper zinc-cadmium solder, designated here as silver solder D.

This silver solder has a melting and flow point below 1200 deg. F. and is used very extensively on ferrous alloys and nickel base alloys. Comparative tests of the two solders were obtained on 18-8 stainless steels, cold rolled steel, copper, nickel and Monel brazed to each other and copper joined to tungsten-copper Elkonite. The dimensions of the test samples are the same as shown in Fig. 1. The samples were prepared by placing the solder and flux in position, butting together the samples to be brazed and then heating the assembly to the brazing temperature. At brazing temperature one of the pieces was moved slightly in order to obtain better wetting.

Six samples of each of the metals were brazed. Varying pressures were applied to the brazed joint while the solder was molten and the pressure was retained until the solder had solidified. Two samples were silver soldered at each of the following pressures:

1 lb. per sq. in.
15 lbs. per sq. in.
100 lbs. per sq. in.

Fig. 6. Tensile strength of brazed joint; nickel brazed to nickel. Not pre-tinned.

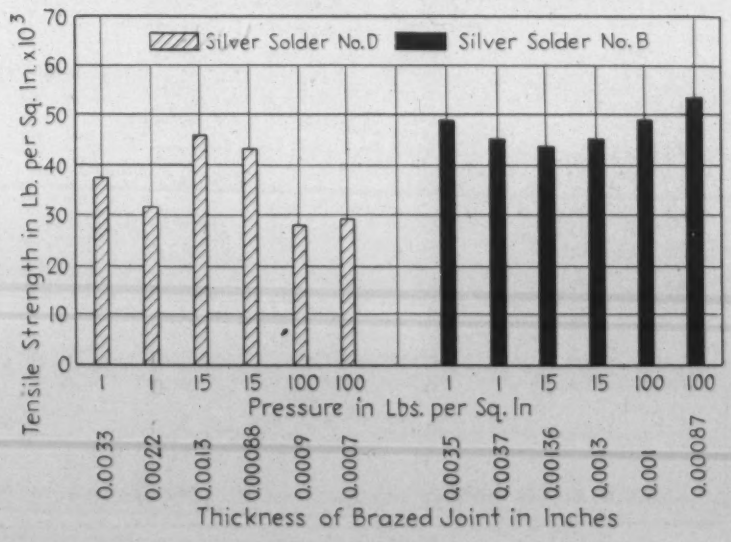


Table IV.—Strength of brazed joints in cold-rolled S.A.E. 1010 steel as affected by the thickness of silver solder film.

Sample No.	Type of silver solder	Thickness of solder film, in.	Tensile strength, lbs. per sq. in.	Pressure, lbs. per sq. in.
1	B	0.0017	47,300	200
2	B	0.0023	45,600	50
3	B	0.0030	45,500	5 lbs. max.
4	A	0.0021	41,300	200
5	A	0.0029	47,300	50
6	A	0.0037	41,800	5 lbs. max.

Note: Pressure was applied to samples Nos. 1, 2, 4 and 5 by means of an arbor press. The pressures were accurately controlled by means of a known weight placed on the arm of the press. Pressure was applied manually to samples Nos. 3 and 6. Only sufficient pressure was applied to hold the pieces together.

After machining to the dimensions shown in Fig. 1, the brazed joint and adjoining surface were polished, the silver solder etched with an etching solution, consisting of sodium chloride, potassium bichromate and sulphuric acid, and the thickness of the joint measured microscopically with a graduated eye-piece. An oxyacetylene torch was used with a slightly reducing flame. Pressure to the braze was applied by means of an arbor press. The tensile test results are shown as a function of pressure and thickness of brazed joint in the attached Fig. 3 to 8, inclusive. A comparison of the results indicates the following:

1. The most consistent results are shown with lithium-bearing silver solder B.
2. For S.A.E.-1010 steel, both silver solders give consistent tensile strength values. The values obtained with cadmium-bearing silver solder D are slightly higher than those obtained with silver solder B.
3. For brazing copper to copper, consistently higher strength values were obtained with silver solder B.
4. In the brazing of nickel to nickel, silver solder B gave the highest and most consistent tensile strength values.
5. In the brazing of copper to tungsten-copper, the silver solder B gave the highest and most consistent tensile strength values.
6. In the brazing of Monel to Monel, silver solder B gave the higher, more consistent tensile strength values.

The variations in pressure and silver solder joint thicknesses have the least influence on the tensile properties of the joint with silver solder B, which indicates that under varying operating conditions this new brazing alloy will provide a reliable and uniformly brazed joint. It was observed that on all test samples, the silver solder B flowed more readily and freely than silver solder D.

Conclusions

This article reports a series of brazing tests with a lithium-bearing silver solder. A comparison of this new silver solder with some of the standard silver solders indicates that, particularly on large brazed sections, this new material is superior so far as fluidity, wetting and resulting tensile and cross-breaking strength properties are concerned. The superiority was shown not only in the brazing of copper to tungsten-copper, but also in the brazing of certain ferrous and non-ferrous materials. The new brazing alloy is particularly useful in the brazing of nickel or ferrous alloys containing oxidizable ingredients, such as chromium, molybdenum and tungsten. The advantages of the new silver solder are particularly evident if the brazing is carried out without a pre-tinning operation.

In addition to the one type of silver solder described in the paper, experiments have shown that eutectic silver-copper compositions containing nickel and lithium have definite advantages and also that a silver solder containing 60 Ag, 20 Cu, 15 Zn, 4.9 Ni and 0.1 per cent Li, is extremely promising as a high strength, high fluidity brazing medium.

Fig. 7. Tensile strength of brazed joint; copper brazed to tungsten-copper. Not pre-tinned.

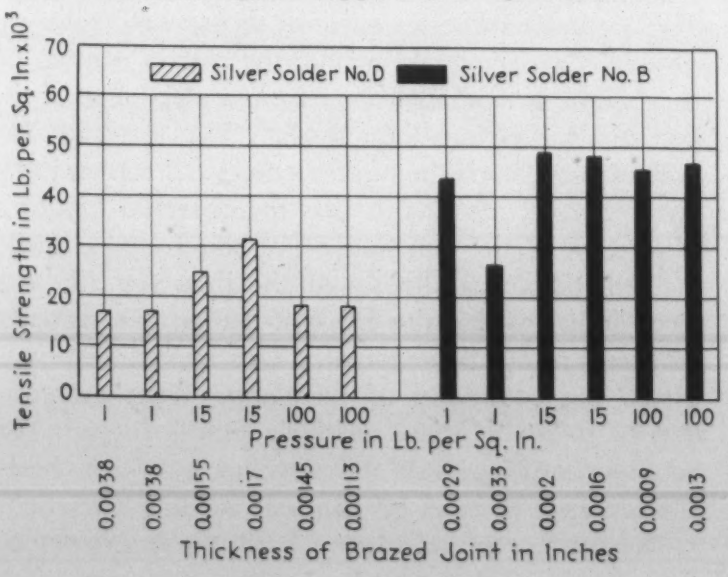
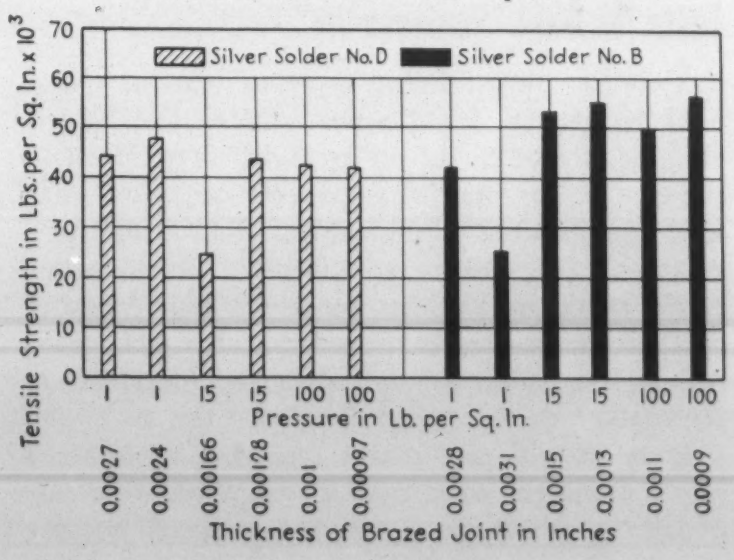


Fig. 8. Tensile strength of brazed joint; Monel metal brazed to Monel metal. Not pre-tinned.



Weld Hardening and

by A. EDSON

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With so much steel being welded for tanks, guns, ships, aircraft and industrial equipment, the problem of weld-cracking—caused by excessive hardening of the steel next to the weld—in fabrication or service assumes major proportions. A valuable feature of this article, therefore, is the presentation therein of an equation and an extremely useful chart, from either of which the weld-hardening tendency of a steel can be estimated if its composition is known—and from which its relative suitability for welding may thus be quickly predicted.

The data and chart may also be used by engineers concerned with the selection of steels on the basis of their hardenability in heat treating. From both the welding and heat treating standpoints the information is of special value for application to the new and unfamiliar "residual" alloy steels now coming into use as alternates. —*The Editors.*

THE IMPORTANCE OF THE HARDNESS developed in the heat-affected zone of steels welded by the metallic arc has been widely recognized in the literature of recent years. Excessive hardening has been found associated with brittleness in the metal adjacent to the weld, with consequent susceptibility to cracking during cooling or fabricating or in service. It is proposed in this article not to define the term "excessive hardening," but to limit the subject to the effect of composition on the hardening response of steel to the welding operation.

Tests for Weld "Hardenability"

Two basically different types of test have been used by investigators to evaluate the relative hardenabilities of steels used for welding. The first type consists of hardness measurements made on small steel samples drastically quenched from a high temperature. The other type involves determination of the maximum hardness beneath a bead deposited by the metallic arc on the surface of a steel plate. Although experimental difficulties and the effects of segregation do not adapt the latter test to critical accuracy, it will give results consistent to within a very few percent when carefully employed. Because it has the advantage of employing actual welding conditions, this type of test, under the following standard conditions, was made the basis of the work reported in this paper:

Electrode	3/16-in. diameter, heavily coated mild steel.
Welding speed	4-¾ in. per min.
Arc voltage	25 volts.
Welding current	180 to 200 amperes.
Polarity	Reversed.
Plate temperature	70 to 80 deg. F.
Plate dimensions	½-in. x 6 in. x 9 in.
Surface bead	Laid along center of 6-in. width.
Start of bead	3 in. from one end of plate.
End of bead	3 in. from other end of plate.
Section for hardness surveys	1 in. from start of bead.

The plates were normalized and ground free from scale before welding. Two heavily coated welding rods were clamped side by side in contact with the plate along its center line to within 3 in. of the end as shown in Fig. 1. A small strip of asbestos paper was placed under the ends of the electrodes to prevent them from freezing to the plate when the arc was started by "striking" with a carbon rod. After deposition of 3 in. of bead, the current was turned off and the plate was placed on a steel table top to cool in still air. The welding rate was determined automatically by the rate of melting of the electrodes, and the use of two parallel electrodes caused the arc to weave uniformly from one to the other. Hardness measurements were made with the Vickers diamond pyramid indenter and a 10-kg. load.

Steel Compositions

The compositions of the steels tested and the maximum hardnesses observed are shown in Table 1. In Fig. 2 these hardnesses adjacent to the weld zone are plotted logarithmically against the carbon content of the carbon, manganese, chromium, molybdenum, copper and nickel-vanadium steels. The fact that for each of these steels the plotted points fall substantially on a straight line reveals that the observed hardness is an exponential function of carbon content, while the remarkable parallelism of the lines for different steels indicates that the effect of carbon is essentially independent of alloy content. This immediately suggested the possibility of calculating from composition by means of some relatively simple formula the hardness which would be developed in the heat-affected zone of steel by standard welding operation.

The concept of calculating hardness from compo-

Steel Composition

sition is not a new one. Equations relating strength and hardness to the composition of hot-rolled structural steels have appeared frequently in the literature. Herty, McBride, and Hollenback[1] evolved an equation which relates maximum and minimum hardnesses to the composition of quenched 1-inch. bars of plain carbon steel, and Burns, Moore, and Archer[2] present a similar equation for the area under the hardness curve of quenched 1-in. bars of carbon steels with residual amounts of nickel, chomium, and copper. Portevin and Seferian[3], in a mathematical treatment of welding, present curves which show the maximum temperatures and cooling rates achieved and enable prediction of hardness and structure if the transformation characteristics of the steels involved are fully known. More recently, Aborn[4] presented an equation from which the minimum cooling time or maximum cooling rate which will yield a fully pearlitic structure may be calculated from "S" curve data, but no expression directly relating composition to weld hardening appears to have been published.

Examination of the data shown in Table 1 revealed that, for steels within a limited composition range, the chemical composition and maximum hardness in the weld zone may be satisfactorily related by a simple exponential expression. Careful evaluation of constants involved yielded the following empirical equation:

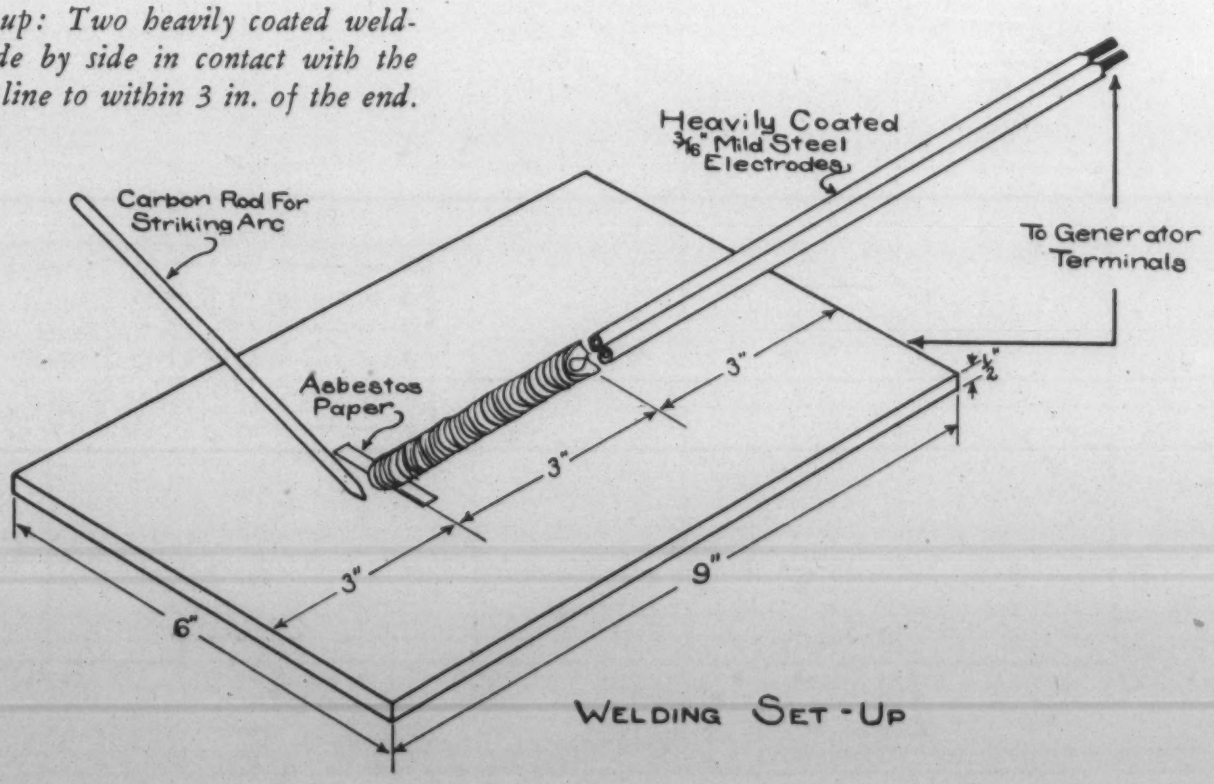
$$\log_{10} \text{Vickers Hardness No.} = 1.957 + 1.141 \times \%\,C + 0.193 \times \%\,Mn + 0.086 \times \%\,Ni + 0.160 \times \%\,Cr + 0.363 \times \%\,Mo + 0.180 \times \%\,V + 0.030 \times \%\,Cu$$

In any empirical equation, it is essential to establish and emphasize the limits of the range over which its use is intended. The error resulting from the use of the above equation will increase rapidly as the limits established are exceeded. The application of the following maximum limits to the equation is intended:

	Per Cent
Carbon	0.50
Manganese	1.75
Silicon	0.40
Nickel	3.75
Chromium	1.25
Molybdenum	0.40
Vanadium	0.30
Copper	2.00
Aluminum	0.05

Attention is directed to the omission of the elements, silicon, aluminum, titanium, phosphorus, and sulphur from the proposed equation. Sulphur and phosphorus contents of the steels tested were consistently near 0.02 per cent, and slight variations of these elements had no measurable effect on hardness. Silicon contents in the range 0.001 to 0.40 per cent did not affect the hardness, and although the effect in unreported tests at higher silicon levels is considerable, it cannot be treated by an equation of this type. Steels 4 to 8 in Table 1 reveal that the effect of aluminum is negligible between 0.004 and 0.038 per cent, while 0.11 to 0.12 per cent Al lowers the hardness 12 to 14 per cent below the predictions of

Fig. 1. Welding set-up: Two heavily coated welding rods, clamped side by side in contact with the plate along its center line to within 3 in. of the end.



the equation. Steels 51 to 58 of Table 1 show that the effect of titanium on weld-zone hardness is determined by the base composition, and indicate that titanium is unfavorable to low weld hardening except in the higher-carbon steels. It is also interesting to note that the relative hardening powers of manganese and carbon in the proposed equation are 1:6, which compares well with the value of 1:7 reached by Theisinger.[5]

It may be seen in Table 1 that the hardness values calculated from the proposed equation for the steels within the established composition limits agree with those obtained experimentally within an average deviation of less than ± 5 per cent, which is near the limit of experimental accuracy for this type of test. As a further test of the validity of the equation, it was applied to a group of steels subjected to weld hardening tests at a welding rate of 6 in. per min. by Bruckner.[6] Comparison of the observed and calculated hardness values for these steels, shown in

Fig. 2. Carbon content vs maximum hardness of 1/2-in. steel plate welded at room temperature.

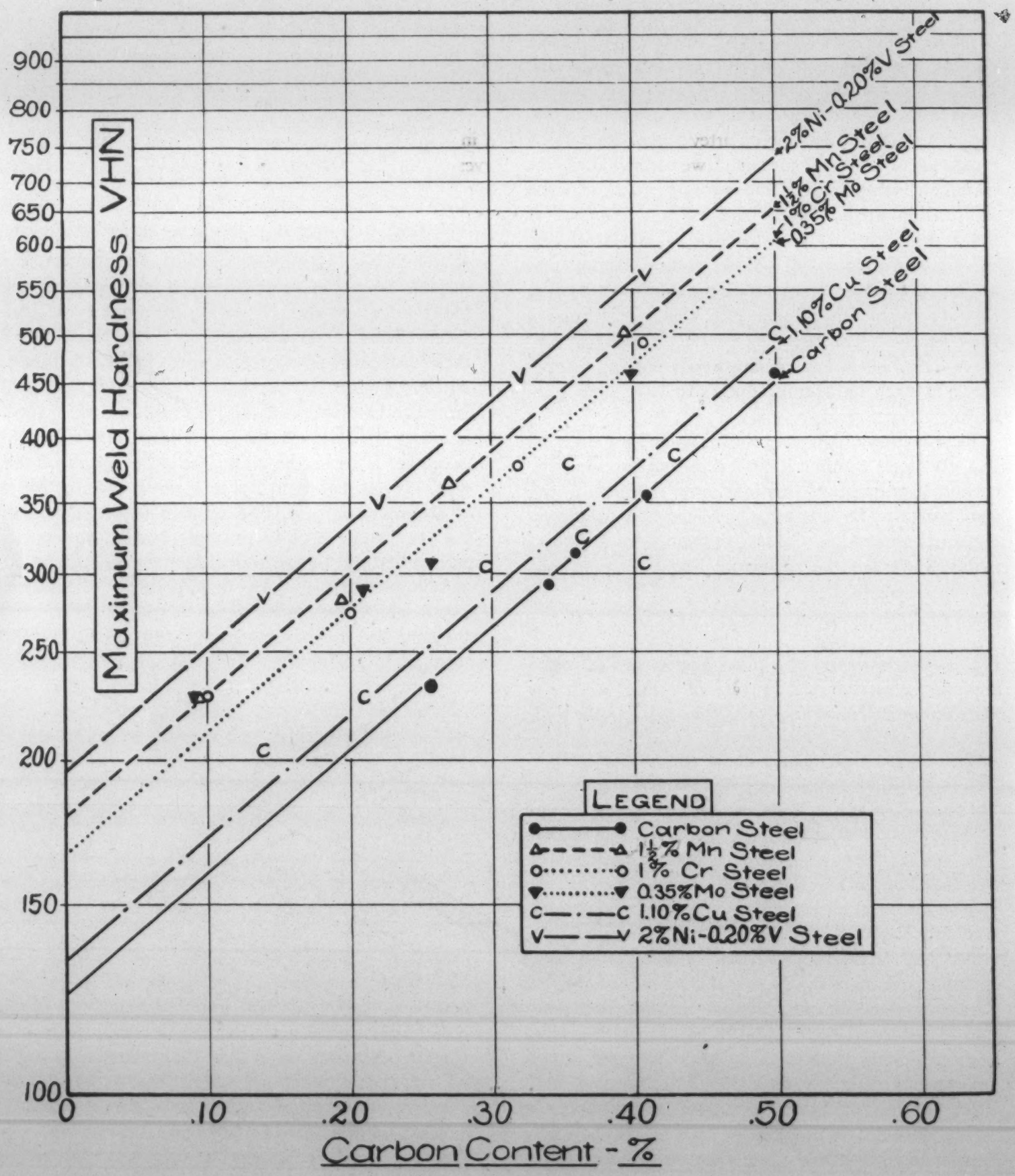


Table 1. Compositions and maximum hardness in the heat-affected zones of welded steel plates (1/2-in. plates welded at room temperature with 3/16-in heavily coated mild steel electrodes; 25 volts, 180-200 amp., 4 3/4 in. per min.)

Specimen	Steel Type	Composition C	Mn	Si	Ni	Cr	Mo	Cu	V	Ti	Al	Observed Max. VHN (1)	(B) Calc'd. Max. VHN (2)	VHN Difference (1-2)	%VHN Difference (1-2)/1
1 (A)	C	0.34	0.65	0.07	...	...	...	...	...	...	(D)	295	296	— 1	0
2 (A)	C	0.36	0.76	0.26	...	...	...	...	...	...	(D)	320	328	— 8	— 2
3 (A)	C	0.41	0.75	0.20*	...	...	...	...	...	...	(D)	355	372	—17	— 5
4 (A)	C	0.50	0.63	0.22	...	...	...	...	...	...	(D)	460	446	+14	+ 3
5	C	0.26	0.71	0.20*	...	...	...	...	...	...	0.004	236	246	—10	— 4
6	C	0.27	0.59	0.15	...	...	...	...	...	...	0.038	227	234	— 7	— 3
7	C	0.31	0.63	0.20*	...	...	...	...	...	...	0.11	240	271	—31	—12
8	C	0.31	0.72	0.20*	...	...	...	...	...	...	0.12	247	282	—35	—14
9 (A)	Mn	0.09	1.57	0.20	...	...	...	...	...	...	(D)	225	230	— 5	— 2
10 (A)	Mn	0.19	1.59	0.20*	...	...	...	...	...	...	(D)	284	302	—18	— 6
11 (A)	Mn	0.27	1.42	0.15	...	...	...	...	...	...	(D)	370	346	+24	+ 7
12 (A)	Mn	0.39	1.42	0.20*	...	...	...	...	...	...	(D)	505	474	+31	+ 6
13 (A)	Cr	0.09	0.62	0.17	...	0.99	...	...	...	...	(D)	227	218	+ 9	+ 4
14 (A)	Cr	0.20	0.54	0.20*	...	1.00*	...	...	...	...	(D)	272	282	—10	— 4
15 (A)	Cr	0.32	0.53	0.20*	...	1.03	...	...	...	...	(D)	375	388	—13	— 4
16 (A)	Cr	0.41	0.38	0.20*	...	1.00*	...	...	...	...	(D)	494	455	+39	+ 8
17 (A)	Mo	0.09	0.88	0.20*	...	...	0.32	...	...	...	(D)	231	222	+ 9	+ 4
18 (A)	Mo	0.21	0.91	0.20*	...	...	0.32*	...	...	...	(D)	293	308	—15	— 5
19 (A)	Mo	0.26	0.76	0.13	...	...	0.32*	...	...	...	(D)	308	328	—20	— 7
20 (A)	Mo	0.40	0.64	0.20*	...	...	0.32*	...	...	...	(D)	463	450	+13	+ 3
21	Cu	0.14	0.75*	0.13	...	...	...	1.10*	...	...	(D)	206	197	+ 9	+ 4
22	Cu	0.21	0.75*	0.16	...	...	...	1.15	...	...	(D)	232	238	— 6	— 3
23	Cu	0.29	0.75*	0.43	...	...	...	1.16	...	...	(D)	306	294	+12	+ 4
24	Cu	0.35	0.75*	0.46	...	...	...	1.11	...	...	(D)	383	342	+41	+11
25	Cu	0.36	0.61	0.20*	...	...	...	1.18	...	...	(D)	325	332	— 7	— 2
26	Cu	0.41	0.48	0.20*	...	...	...	1.10*	...	...	(D)	312	356	—44	—14
27	Cu	0.43	0.71	0.20*	...	...	...	1.10	...	...	(D)	387	369	+18	+ 5
28	Cu	0.50	0.82	0.20*	...	...	...	1.23	...	...	(D)	502	527	—25	— 5
29	Ni-Cu	0.11	0.60	0.20	0.99	...	...	1.03	...	...	(D)	210	206	+ 4	+ 2
30	Ni-Cu	0.12	0.57	0.20*	1.00	...	...	1.05	...	...	(D)	219	209	+10	+ 5
31	Ni-Cr	0.17	0.46	0.20*	1.29	0.60	...	...	...	...	(D)	278	280	— 2	— 1
32	Ni-Mo	0.15	0.50	0.20	1.81	...	0.25	...	...	...	(D)	294	296	— 2	— 1
33	Ni-Mo	0.38	0.63	0.20*	1.63	...	0.30*	...	...	...	(D)	623	577	+46	+ 7
34	Cr-Mo	0.34	0.56	0.20*	...	1.03	0.18	...	...	...	(D)	502	482	+20	+ 4
35	Ni-Cr-Mo	0.20	0.65	0.20*	1.95	0.28	0.29	...	...	...	(D)	418	425	— 7	— 2
36	Ni-Cr-Mo	0.32	0.58	0.20*	1.67	0.54	0.36	...	...	...	(D)	623	623	0	0
37	Ni-Cr-Mo	0.43	0.71	0.20*	1.71	0.65	0.33	...	...	...	(D)	788	904	—116	—14
38	Ni-Cr-Mo	0.42	0.63	0.20*	1.35	0.57	0.27	...	...	...	(D)	720	730	—10	— 2
39	Ni-Cu-Mo	0.09	0.66	0.16	1.03	...	0.19	1.06	...	...	(D)	232	238	— 6	— 3
40	Ni-Cu-Mo	0.10	0.82	0.21	1.00	...	0.21	1.01	...	...	(D)	233	264	—31	—13
41	Ni-Cu-Mo	0.10	0.98	0.22	0.97	...	0.19	1.02	...	...	(D)	273	278	— 5	— 2
42	Ni-Cu-Mo	0.10	1.00	0.23	0.63	...	0.20*	0.66	...	...	(D)	246	258	—12	— 5
43	Ni-Cu-Mo	0.17	0.88	0.20*	1.00*	...	0.20*	1.02	...	...	(D)	360	324	+36	+10
44	Ni-Cu-Mo	0.18	0.78	0.20*	0.98	...	0.22	1.00	...	...	(D)	303	322	—19	— 6
45	Ni-Cu-Mo	0.19	0.73	0.20	1.00	...	0.20	1.08	...	...	(D)	363	321	+42	+12
46	Ni-Cu-Mo	0.21	0.95	0.23	0.65	...	0.19	0.66	...	...	(D)	349	335	+14	+ 4
47	Ni-V	0.14	0.65*	0.11	2.00	...	...	...	0.20*	...	(D)	283	282	+ 1	0
48	Ni-V	0.22	0.64	0.20*	2.00*	...	...	...	0.20*	...	(D)	351	347	+ 4	+ 1
49	Ni-V	0.32	0.65	0.20*	2.00*	...	...	...	0.21	...	(D)	455	454	+ 1	0
50	Ni-V	0.41	0.67	0.20*	2.00*	...	...	...	0.20	...	(D)	566	578	—12	— 2
51	Ni-Ti	0.43	0.65*	0.19	2.00	...	...	...	...	0.20	(D)	585	556	+29	+ 5
52	Ni-Ti	0.39	0.66	0.15	2.00*	...	...	...	...	0.28	(D)	530	491	+39	+ 7
53	Ni-Ti	0.28	0.66	0.20*	2.00*	...	...	...	...	0.55	(D)	376	386	—10	— 3
54	Ni-Ti	0.28	0.65*	0.20*	1.98	...	...	...	...	0.58	(D)	401	384	+17	+ 4
55	Ni-Ti	0.50	0.65*	0.20*	2.00*	...	...	...	...	0.56	(D)	493	667	—174	—35
56	Ni-Ti	0.56	0.65*	0.20*	2.00	...	...	...	...	0.54	(D)	627	782	—155	—24
57	Ni-Ti	0.64	0.69	0.31	2.00	...	...	...	...	0.50	(D)	642	982	—340	—53
58	Mn-Ti	0.15	1.44	...	...	...	...	...		0.37		336	254	+82	+24

(A) H. J. French and T. N. Armstrong, *Welding Journal*, October 1939, page 339-s.
(B) Calculated from equation: $\text{Log}_{10}\ \text{VHN} = 1.957 + 1.141 \times \%C + 0.193 \times \%Mn + 0.086 \times \%Ni + 0.160 \times \%Cr + 0.363 \times \%Mo + 0.180 \times \%V + 0.030 \times \%Cu$.
(D) 0.03% aluminum added immediately before pouring.
* Approximate value.

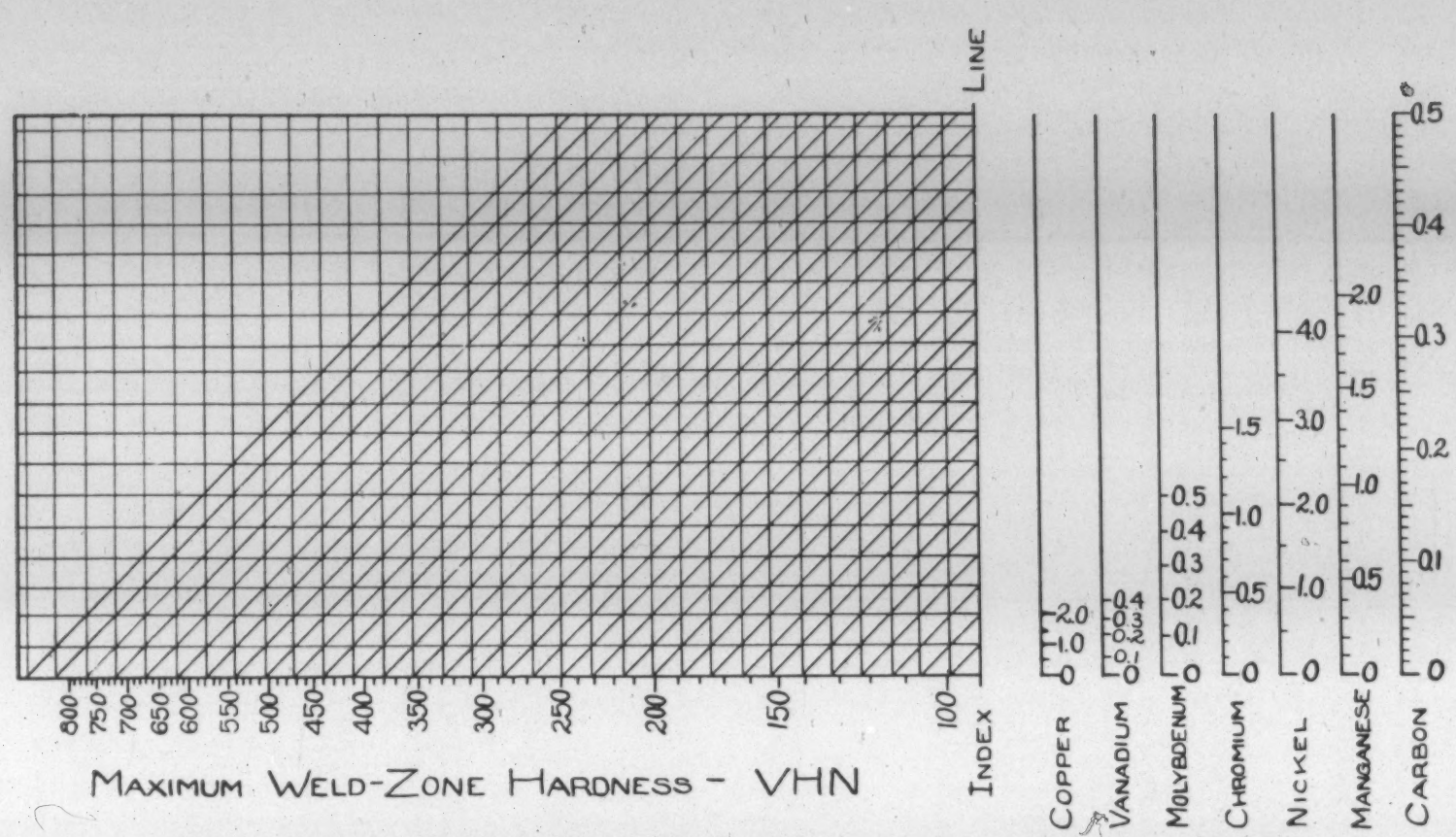


Fig. 3. A chart which permits graphical conversion from composition to hardness.

Table 2. Compositions and maximum hardness in the heat-affected zones of welded steel plates (Data from the paper by W. H. Bruckner, Proc. Amer. Soc. Testing Materials, Vol. 38, page 71; 1/2-in. plates welded at room temperature with 3/16-in. heavily coated electrodes; 23 volts, 180 amp., 6 in. per min.)

Specimen	Steel Type	Composition C	Mn	Si	Ni	Cr	Mo	V	Cu	Observed Max. VHN (1)	Calc'd Max. VHN[a] (2)	VHN Difference (1-2)	%VHN Difference[b] (1-2)/1
1	C	0.17	0.41	0.17	...	...	...	...	...	193	170	+23	+12
5	C	0.21	0.38	0.003	...	...	...	...	...	203	186	+17	+ 8
20	C	0.24	0.46	0.001	...	...	...	...	...	218	209	+ 9	+ 4
9	C	0.24	0.48	0.23	...	...	...	...	...	224	211	+13	+ 6
2	C	0.25	0.43	0.20	...	...	...	...	...	221	212	+ 9	+ 4
15	C	0.25	0.43	0.20	...	...	...	...	...	227	212	+15	+ 7
13	C	0.26	0.46	0.005	...	...	...	...	...	230	220	+10	+ 4
B	C	0.26	0.64	0.20	...	...	...	...	...	237	239	— 2	— 1
6	C	0.27	0.47	0.002	...	...	...	...	...	243	227	+16	+ 7
10	C	0.27	0.74	0.21	...	...	...	...	...	289	256	+33	+11
14	C	0.28	0.54	0.058	...	...	...	...	...	237	240	— 3	— 1
3	C	0.35	0.68	0.23	...	...	...	...	...	266	308	—42	—16
22	Mn	0.18	1.40	0.21	...	...	...	...	...	312	271	+41	+13
11	Mn	0.29	1.06	0.25	...	...	...	...	...	312	310	+ 2	+ 1
32	Cr	0.12	0.75	0.48	...	0.34	...	...	...	221	196	+25	+11
21	V	0.25	0.43	0.19	...	...	...	0.12	...	243	228	+15	+ 6
17	Mo	0.22	0.52	0.20	...	...	0.19	...	...	230	238	— 8	— 3
29	Ni	0.028	0.19	...	2.08	...	...	...	...	170	161	+ 9	+ 5
35	Ni	0.27	0.69	0.20	2.31	...	...	...	...	383	394	—11	— 3
36	Ni	0.27	0.69	0.21	2.30	...	...	...	...	446	392	+54	+12
24	Ni	0.28	0.56	0.27	3.57	...	...	...	...	503	492	+11	+ 2
27	Ni-Cu	0.06	0.35	0.002	1.95	...	...	...	0.94	195	195	0	0
28	Ni-Cu	0.21	0.70	0.27	1.97	...	...	...	1.08	405	349	+54	+14
30	Ni-Cu-Mo	0.09	0.72	0.047	0.96	...	0.11	...	1.34	254	233	+21	+ 8
31	Ni-Cu-Mo	0.24	0.74	0.012	0.76	...	0.16	...	1.48	397	348	+49	+12
23	Cu-Mo	0.15	0.44	0.20	...	...	0.17	...	0.75	237	196	+41	+17

(a) Calculated from equation $\log_{10} VHN = 1.957 + 1.141 \times \%C + 0.193 \times \%Mn + 0.086 \times \%Ni + 0.160 \times \%Cr + 0.363 \times \%Mo + 0.180 \times \%V + 0.030 \times \%Cu$.

(b) Average $= + 5 \pm 6\%$.

Table 2, reveals that the calculated values are displaced about 5 per cent below those observed, and deviate from this level by an amount of less than $\pm$ 6 per cent. The deviation of $\pm$ 6 per cent is considered excellent agreement, and the displacement of 5 per cent is readily explained by the higher welding rate used by Bruckner. That the differences between calculated and observed hardness are not greater than those between observed values for closely similar steels is shown by comparison of Bruckner's Steels 35 and 36 which differ 16 per cent in observed hardness with but 1 point difference in nickel and silicon content.

Chart Facilitates Calculations

In order to facilitate the calculation of hardening from chemical composition and to evade the reluctance of many persons to handle equations, a chart which permits graphical conversion from composition to hardness is presented in Fig. 3. Because this is simply another form of the equation previously presented, the same limits of composition and welding conditions apply. In using this graph, the elements involved may most conveniently be taken in order of the scales from right to left. A line is carried horizontally from the carbon content to the index line, and from there parallel to the diagonal guide lines until it intersects the base line. From the base line intercept it is projected vertically to intersect a horizontal projection of the manganese content. From this point it is carried diagonally down to the base line, vertically to intersect a horizontal projection of the nickel content, and again diagonally to the base line. This process is continued until all the elements involved have been covered, when the final base line intercept will represent the maximum hardness developed by the standard test described. Alternatively, the elements may be taken from the scales with dividers or a ruler and laid off additively along the base line from the index line to determine the hardness.

Before closing, passing attention may be directed to the effects of variations of welding conditions from the standards set. Although the exact effects of changes of conditions are the subject of general disagreement, the basic trends are well recognized. Hardness in the zone adjacent to the weld is usually increased by increase of plate thickness or welding rate and decreased by increase of welding current or plate temperature. Only experience can make possible the translation of the hardness developed in a standard test into the hardness to be expected from process welds made under different conditions, but the equation and graphical solution submitted in this paper are capable of giving definite comparative ratings on the hardening response of a great range of steels to the welding operation.

References

[1] C. H. Herty, Jr., D. L. McBride, and E. H. Hollenback—*Trans. Amer. Soc. Metals,* Vol. 35, page 297.

[2] J. L. Burns, T. L. Moore, and R. S. Archer—*Trans. Amer. Soc. Metals,* Vol. 26, page 1.

[3] A. Portevin and D. Seferian—*Chaleur et Industrie,* September, 1935, page 409.

[4] R. H. Aborn—*Welding Journal,* October, 1940, page 414-s.

[5] W. G. Theisinger, Report to Committee A1, Amer. Soc. Testing Materials January, 1937.

[6] W. H. Bruckner—*Welding Journal,* October, 1937, Supplement page 53.

A Few Chuckles

"Crystallization" bows to "Grain Growth"

To the Editor: On page 238 in *Diesel Power* for March 1942 under the caption "Making Connections that will Resist Vibration," appears the following statement:

> "It does not seem to be well known that vibrating machinery often causes failures that do not occur on non-vibrating machinery. * * * In such cases the vibration of the machinery is sufficient to cause rapid *grain growth of the metal,* and, as a result, early fracture takes place at the point of connection" (of piping, etc.).

Of all places, this article is sandwiched in between the "How is Your I-Q" section and the answers. At least, no mention was made of "crystallization," for which Allah be praised!

THOMAS C. RATHBONE

Chief Engineer
Turbine and Machinery Div.
The Fidelity and Casualty Co. of New York

Silver Boullion!

Information Digest, Office of Government Reports, No. 432, March 3, 1942, page 8:

> "Silver boullion may be exported only to Canada, Great Britain and Northern Ireland, Newfoundland, Greenland and Iceland."

Used in Ireland as a base for Irish stew, we judge.

—H. W. G.

Priorities, Allocations and Price Controls!

Chemical Industries, Feb. 1942, page 295, dealing with the chronology of priorities, allocations and price controls, under heading "tin" says:

"Price ceiling No. 17, effective Aug. 16, sets price of 52 cents per lb. for Grade A pig *iron.*"

We also note on page 266 that 69,000 *gal.* of phosphorus is to be supplied Latin America in the first 3 months of '42.

Maybeso tank car shipments, but it's news to us. Italics ours.

—H. W. G.

Anodic Coatings on Aluminum

—Their Brittleness

By H. N. HILL and R. B. MASON

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The widely-employed anodic treatment of aluminum and its alloys to increase corrosion- and wear-resistance may be accomplished by either chemical or electrolytic processes. Such coatings have various hardnesses, depending on the manufacturing method used, and show corresponding variations in brittleness. The tests reported here were made to ascertain whether such coatings are brittle enough to be used in the "brittle coating" method for indicating strain distributions. Although the answer to this was found to be "no," the article does show that these coatings —often comparable in hardness to corundum—are surprisingly elastic. —*The Editors.*

ARTIFICIAL OXIDE COATINGS on aluminum may be of various degrees of hardness, depending on the way they were made. The coatings formed by chemical treatment only, sometimes called dip coatings, are relatively soft and may be even of a powdery nature at times. The oxide coatings produced by electrochemical means (that is, by anodic treatment in various electrolytes) are quite hard and adhere tenaciously to the base metal.

Anodic oxide coatings on aluminum in some respects are comparable in hardness with their mineral counterpart, corundum. The thick oxide coatings produced in sulphuric or oxalic acid electrolyte by anodic treatment at or below room temperature are hard, abrasion-resistant and corrosion-resistant. The films produced in chromic acid under the usual operating conditions are much thinner than those produced in sulphuric and oxalic acids. These hard oxide films on aluminum are naturally also brittle.

Some tests have been made to measure the brittleness of various types of anodic coatings on 53 S-T aluminum alloy sheet. These tests were made to determine whether or not such coatings are brittle enough to be used in the "brittle coating" method [1] for indicating strain distributions on the surface of a stressed piece. Extreme brittleness of the coating would not be essential to the use of the method for indicating the location of points of maximum stress; but to be satisfactory for obtaining quantitative results, the oxide coating would have to crack when subjected to strains well within the elastic range of the base metal. The data are also of general interest in connection with the commercial applications of these coatings.

Qualitative Test of Brittleness

A qualitative observation of brittleness is the fact that a crackling noise can generally be heard when the underlying metal is bent slightly. Fine hairline cracks can be seen with the naked eye, provided the incident light strikes the surface at the proper angle. These extremely fine cracks may almost entirely disappear when the metal is bent back to its original position. When aluminum sheet, coated with a hard oxide film, is cut with shears or scratched with a scriber, fine hairline cracks will develop in the region where the base metal was disturbed. Although the oxide coating is brittle, it adheres tenaciously to the base metal and repeated bendings do not cause it to scale off or loosen.

Table I—Anodic Treatments Given 53 S-T Tensile Specimens.

Specimen No.	Electrolyte	Current density, (amp. per sq. ft.)	Temperature (Deg. Fahr.)	E.M.F. (Volts)	Time, (min.)	Sealing treatment
1	H_2SO_4, 15%	12	76	17	30	Unsealed
2	H_2SO_4, 15%	12	76	17	30	30 min. in boiling distilled H_2O
3	H_2SO_4, 15%	12	76	17	30	30 min. in boiling 5% $K_2Cr_2O_7$
4	H_2SO_4, 7%	12	74–83	20	30	Unsealed
5	$(COOH)_2$, 3%	12	80–97	46	30	Unsealed
6	CrO_3 9.5%	2.5	95	40	30	Unsealed

Although the anodic coatings under consideration are hard and brittle, they are also porous. The pores run from the oxide surface to the metal base and give the coating a fibrous structure.[2] An oxide coating can be sealed by closing the pores in some manner. Sealing is usually accomplished by immersion in boiling water. This treatment converts aluminum oxide (Al_2O_3) to the monohydrate ($Al_2O_3 \cdot H_2O$) and seems to change the fibrous nature of the coating, especially in the outer layer. Sealed oxide coatings may have a lower abrasion resistance than unsealed coatings.[3]

Six Special Test Pieces

For the purpose of evaluating the brittleness of various anodic coatings, six standard tensile specimens were machined from a piece of B. & S. No. 14 gage (0.064 in.) 53 S-T sheet (Nominal composition: Magnesium 1.3%, silicon 0.7%, chromium 0.25%,) which had a tensile yield strength of 36,000 lbs. per sq. in. and an elastic limit of about 22,000 lbs. per sq. in. Since the modulus of elasticity of 53 S-T is about 10,000,000 lbs. per sq. in., the unit strain corresponding to the elastic limit stress of 22,000 lbs. per sq. in. would be about 0.0022 in. per in. Therefore, for the coating to crack within the elastic range of the base metal, cracks would have to occur at some value of unit strain less than 0.0022 in. per in.

The specimens were given oxide coatings by various anodic treatments, as described in Table I. In two cases the oxide coating was sealed.

The specimens were loaded in an Amsler hydraulic testing machine, using Templin grips. Load was applied in increments, so as to produce uniform increments of strain. Strain was measured with a modified Riehle extensometer of 2-in. gage length, with which strains as small as 0.00002 in. per in. could be estimated. After each increment of strain had been attained, one side of the specimen was examined for cracks, through a 42-power microscope. Because of the slight stress concentration produced by the change in section, cracks in the coating should occur first at the point of tangency of the fillet and the straight side of the reduced portion of the specimen. One such region was examined continuously as each increment of strain was being applied, and the strain reading was recorded at which the first crack was observed.

The appearance of a crack at this point of tangency was followed by the formation of cracks on the reduced portion of the specimen, at a slight increase in the amount of strain. Further straining increased the number of cracks. One of the first cracks to appear on the reduced portion of the specimen was marked as a reference. As each additional increment

Fig. 1. Data plotted for the six specimens showing brittleness of the anodic coatings. See Table I for a description of the coatings.

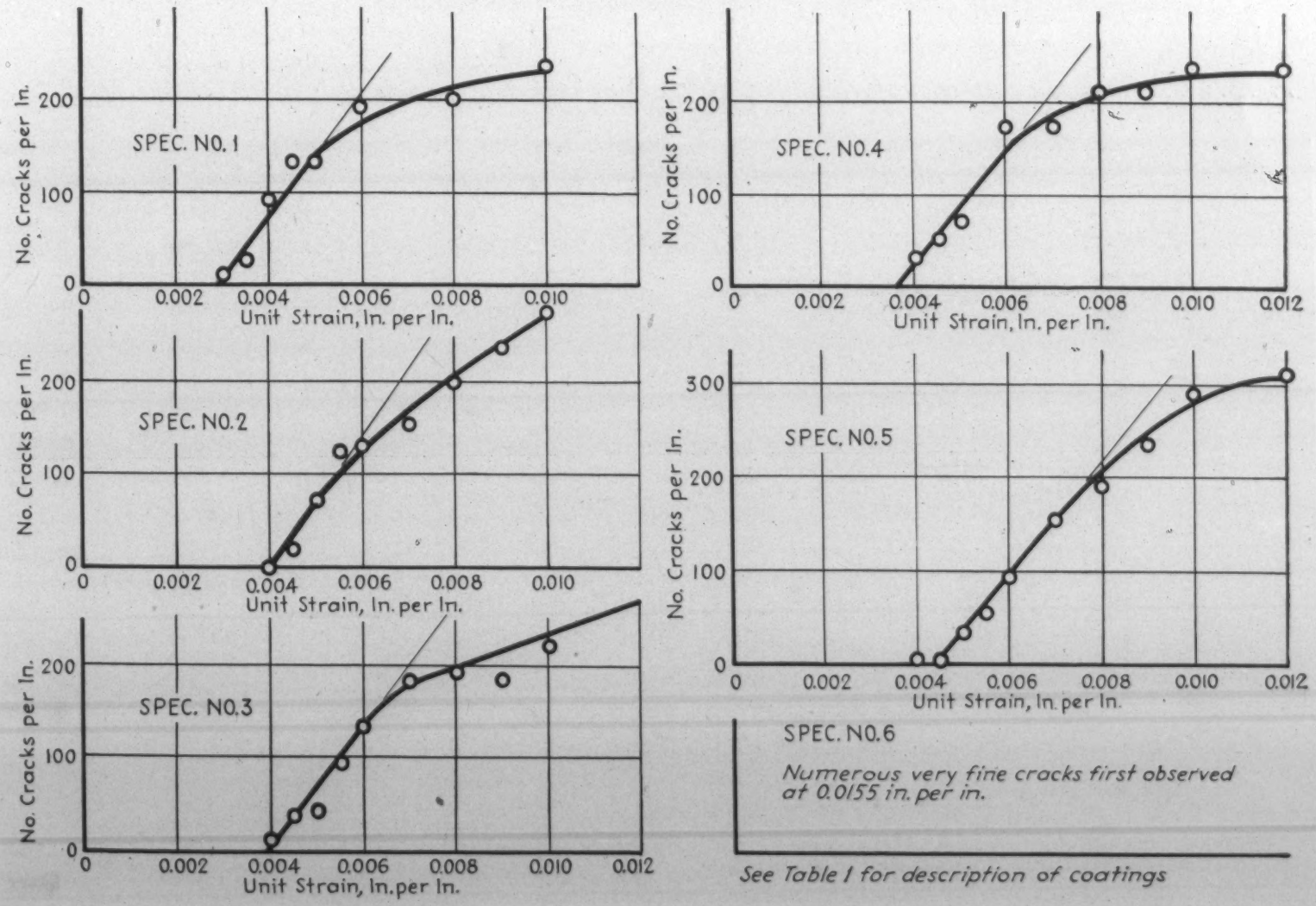


Fig. 2. Metallic copper deposited along cracks.

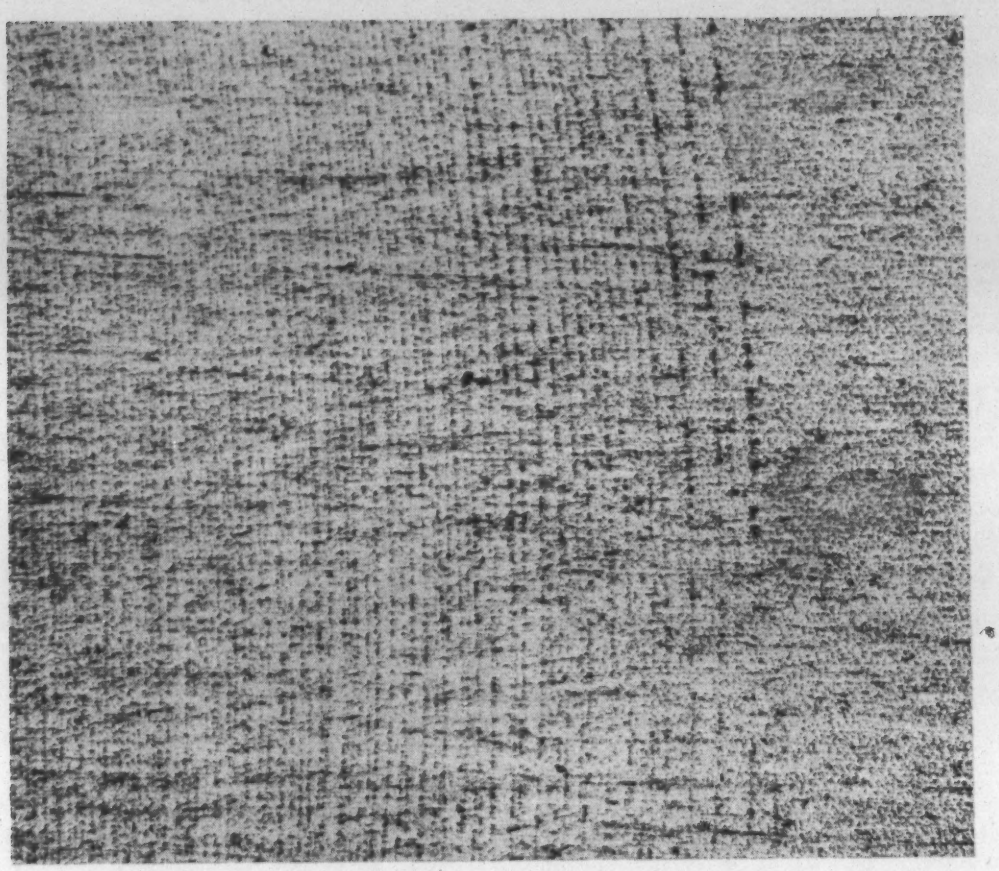


Fig. 3. Cracks in anodic coating on specimen No. 5 after being subjected to a unit strain of 0.012. Mag. about 7X.

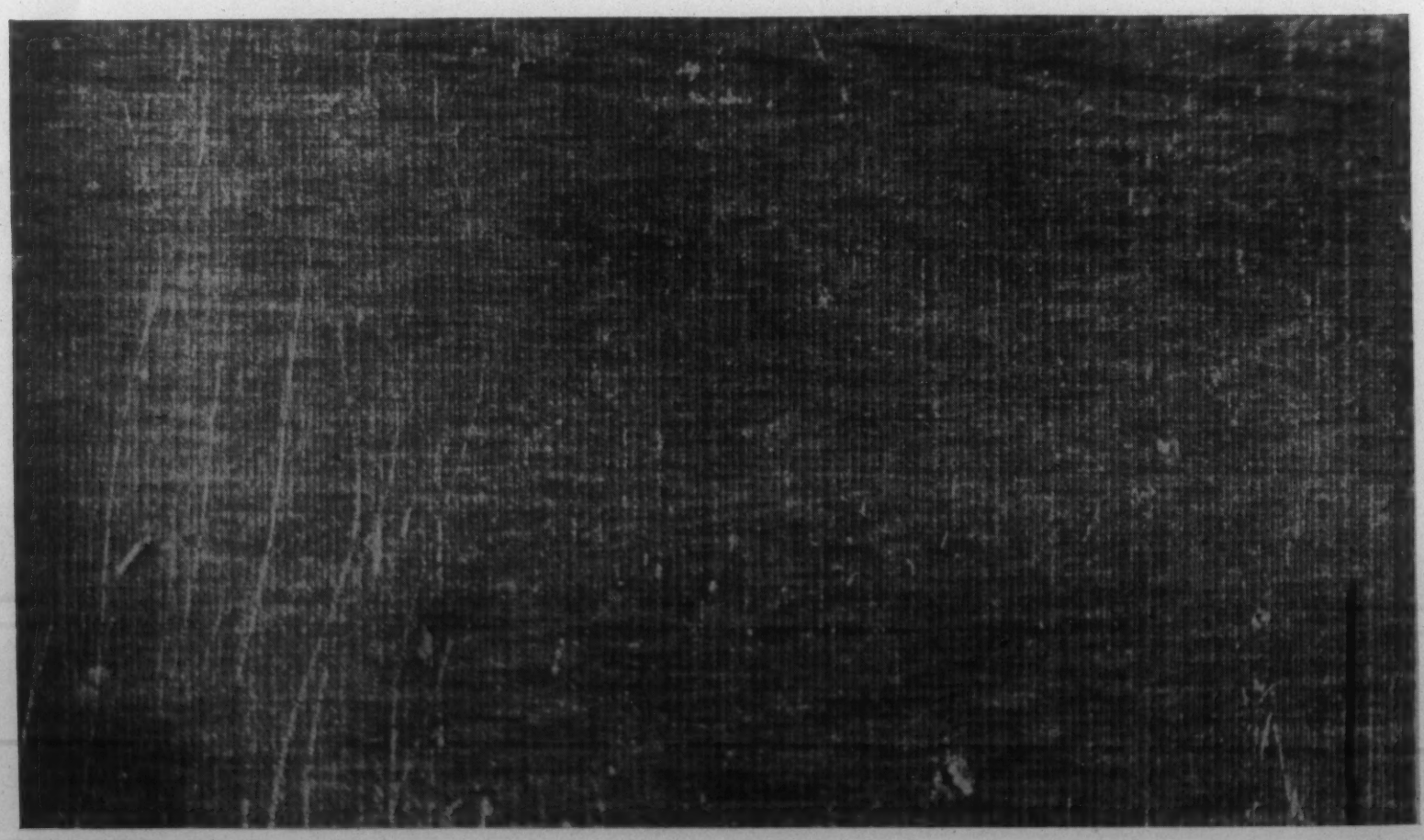


Table II—Unit Strains at Which First Cracks Appeared in the Straight Portions of the Specimens.

Specimen No.	Unit Strain at First Crack, in. per in.
1	0.0029
2	0.0040
3	0.0039
4	0.0036
5	0.0045
6	0.0155

of strain was attained, the distance was measured between this reference crack and the fifth crack from it (always in the same direction). This reading gave a measure of the spacing of the cracks. The spacing was not uniform but the measurement thus obtained provided a reasonable average value.

The data obtained have been plotted in Fig. 1 for the six specimens tested. These curves show the density of cracks, expressed as the number of cracks per inch, plotted against the unit strain. Deviation of the plotted points from the faired curves reflects the limitation of accuracy of the determination of the crack density.

Effect of Stressing

It was considered possible that cracks which are too small to be readily seen under the microscope might be formed when an anodically coated aluminum specimen is bent or stressed. When an oxide coated specimen of aluminum is placed in a solution containing 20 g. per l. of sodium chloride and 1 g. per l. of copper nitrate, the ions of the solution penetrate the weak spots; copper is deposited on the aluminum, and is readily visible. Using this method of test, it should be possible to detect even minute cracks in the oxide film.

A piece of 53 S-T 14-gage sheet, 9 in. by ½ in., was anodically coated in 15 per cent sulphuric acid for 30 mins., and then sealed in boiling water. The coated specimen was then supported at both ends and loaded so as to produce a stress which was slightly less than that required to cause visible cracking of the oxide coating. The specimen was immersed in the test solution while under stress and allowed to stand for about 30 mins. There was no indication of any *cracks* in the oxide coating although the coating had been penetrated by the solution in many spots.

Another similar specimen was bent until definite cracks appeared in the oxide coating. The limiting cracks which could be seen under the microscope were marked with a pencil and the specimen placed in the sodium chloride-copper nitrate solution and left for about 5 minutes. Copper was deposited along the cracks but there was no indication of other cracks in the oxide coating beyond the region of visible cracks. A photograph of the surface with copper deposited along the cracks is shown in Fig. 2. From the results of this test it can be concluded that either this method is not sensitive enough to detect invisible cracks or, as is probably the case, no cracks occur in the oxide coating which are not visible under the microscope.

Table II gives the values of unit strain corresponding to the appearance of the first cracks in the various specimens. Curves of crack density plotted against unit strain are shown in Fig. 1 for all of the specimens tested, with the exception of specimen No. 6. No cracks were visible in the coating on this specimen until a unit strain of about 0.0155 in. per in. had been reached, at which time an intricate network of very fine cracks was observed. These cracks were quite different from those which appeared on the other specimens. The photograph shown in Fig. 3 is typical of all of the specimens, except No. 6. The cracks produced a series of parallel lines running continuously across the specimen.

The general similarity of the curves in Fig. 2 indicates that the coatings produced by the different treatments behaved in about the same manner. After the first crack appeared, the density of the cracks increased at a constant rate with an increase in strain up to a certain point, beyond which the number of cracks increased at a decreasing rate.

Conclusions

In conclusion, it may be stated: The oxide coatings produced on aluminum alloy 53 S-T by anodic treatment were not brittle enough to be satisfactorily used to indicate the strain distribution on the surface of a stressed specimen. In fact, cracks did not occur in the coating until the material had been strained beyond its elastic limit (0.0022 in. per in.). Sealing by immersion in boiling distilled water or a hot dichromate solution slightly reduced the brittleness of the coating. The data show that these coatings are surprisingly elastic in spite of their mineral-like hardness.

References

[1] "Brittle Lacquers as an Aid to Stress Analysis," by A. V. de Forest and Greer Ellis, *J. Aeronaut. Sci.*, Mar. 1940, page 205.

[2] J. D. Edwards and F. Keller, *Electrochem. Soc.*, Vol. 79, 1941, *Preprint.*

[3] "Anodic Coating of Aluminum," by J. D. Edwards, *Monthly Rev. Am. Electroplaters' Soc.*, Vol. 26, 1939, page 513.

PART II

Desulphurization in the Open-Hearth

by FRANK W. SCOTT and T. L. JOSEPH

Asst. Prof. of Metallurgy and Professor of Metallurgy, respectively, Univ. of Minn., Minneapolis, Minn.

In this second instalment of their report on steel-making slags, the authors demonstrate the powerful effect of iron oxide content on desulphurization. Some very useful tables of sulphur distribution versus iron oxide in the slag and slag basicity are included.
—The Editors.

Iron Oxide Content of the Slag

The data on the relationship of the concentration of iron oxide in the slag to the sulphur distribution coefficient are of particular interest.

The introduction of silicon and carbon into the metal bath increased the values of the sulphur distribution coefficients. That this increased desulphurizing power of the slag is due to the reduction of the iron oxide in the slag is shown in Table 3. At any temperature, the top figure gives the FeO in the slag over an oxidized bath. The second figure gives the FeO in the slag over a bath partly deoxidized with silicon. No FeO is reported for the completely deoxidized bath for reasons previously stated. It was very low, however, as it would fall below the values for the bath containing silicon.

The effect of iron oxide on the desulphurizing power of a lime-silica slag is of the greatest importance. Small amounts of iron oxide in a basic slag reduce its desulphurizing power tremendously. Iron oxide in the slag exerts a much greater effect than changes in basicity or changes in temperature.

Sulphur Distribution Equilibrium Constants

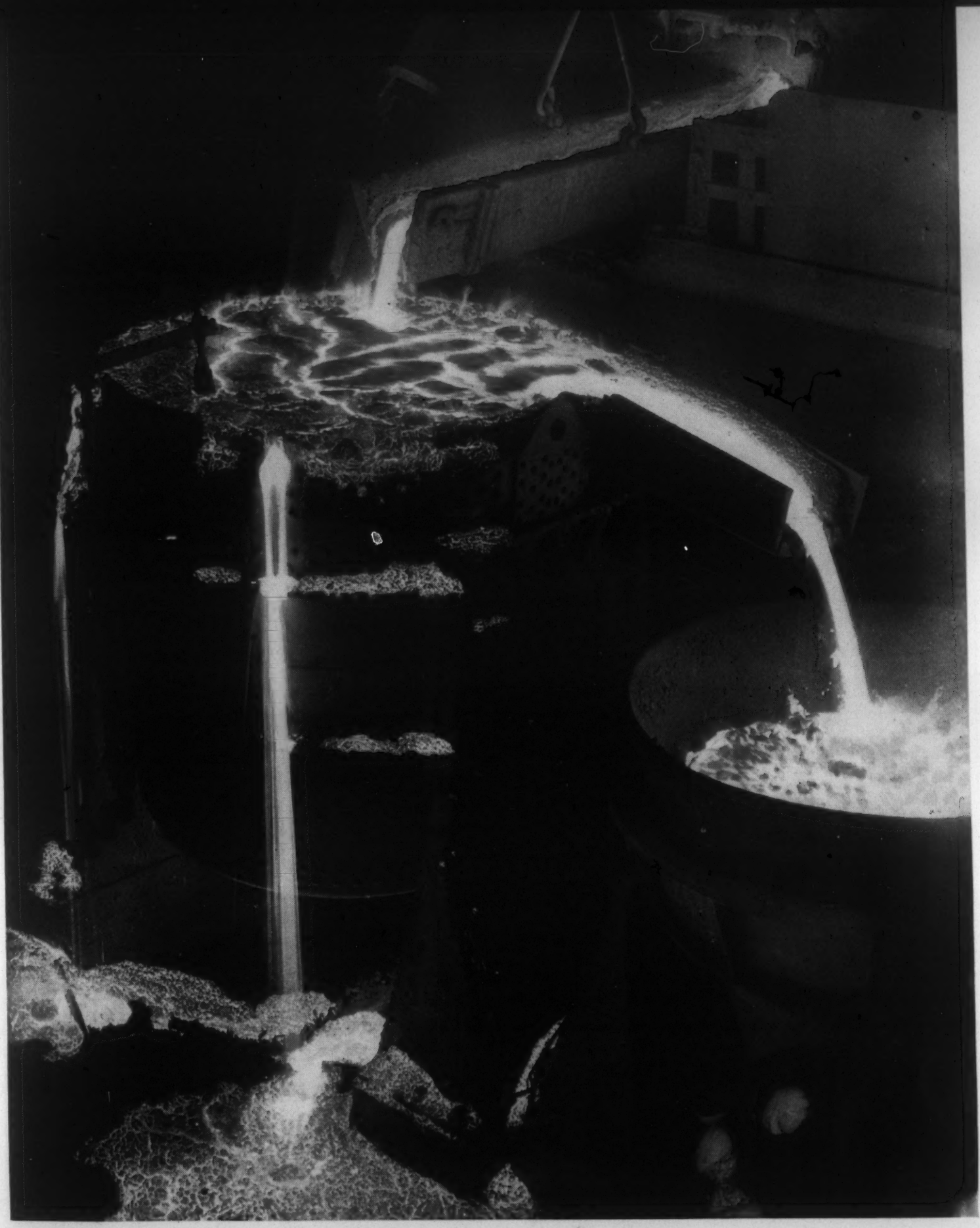
The relationship of slag basicity to the sulphur distribution equilibrium constant with controlled oxidation of metal bath was also established. The value of the sulphur distribution equilibrium constant is determined by the expression—

$$\frac{(FeO)}{(CaO)} \times \frac{\%S_s}{\%S_m} = K_s$$

The FeO is the total concentration of FeO in the slag expressed as mol fractions. Similarly, the CaO is the total concentration of CaO in the slag expressed as mol fractions. No attempt has been made to differentiate between the FeO or CaO combined in a stable silicate or the FeO and CaO that is "free" and capable of entering into the desulphurization reaction. The effect of using the total concentration of both FeO and CaO upon the numerical value of K_s is very noticeable when the FeO is manipulated by controlling the oxidation of the bath.

Under oxidizing conditions, a considerable amount of FeO is combined as a silicate when the basicity is less than unity. As FeO acts as a base, this silicate results in the formation of a more basic calcium silicate which favors a higher value for the sulphur distribution coefficient. The "free" FeO, which is in equilibrium with the iron oxide in the metal, retards the desulphurization and lowers the value of the sulphur distribution coefficient. The value of K_s in Table 4 for the most acid slag, under oxidizing conditions, is large, because the value of FeO used in the calculation is the total concentration of FeO in the slag and not the concentration of "free" FeO.

When the value of R is 1.0 or higher, little or no iron oxide exists as a silicate. This is shown by the values for K_s in Table 4 and by the graph of the values in Fig. 3. In these more basic slags, the iron oxide may be considered to be "free" and to affect the desulphurization of the metal. This is indicated by the close agreement in the values for K_s



Tapping a heat of steel from an open-hearth furnace. Slag is running over the sides of the ladle and into a receiver. (Courtesy: United States Steel Corp.)

that were determined under oxidizing conditions for all the slags except the $CaO \cdot 2SiO_2$ series.

With the silicon-deoxidized bath, a considerable proportion of the combined FeO as well as the "free" FeO is reduced. This reduction of FeO from the silicate phase tends to increase the acidity of the slag and hence to reduce its desulphurizing power. Any reduction of the "free" FeO will increase the desulphurizing power of the slag. Reference to Table 3 shows that a reduction in the total iron oxide in the slag has little effect upon the sulphur distribution coefficients when the basicity is less than unity. Table 4 and Fig. 4 show, however, that the values of K_s are lower when the values of FeO are lower in the case of deoxidized acid slags.

The effect of increasing temperature is to increase the desulphurizing power of the slag under consideration. Also, the value of the equilibrium constant increases as the temperature is increased. This increase in equilibrium constant indicates that the reaction is endothermic and is favored by higher temperatures.

Summary

Iron oxide has a greater effect than any other factor upon the desulphurizing power of a basic slag. The sulphur distribution coefficient is increased more than 200 times when the iron oxide is reduced by saturating the steel with carbon.

When the lime-silica ratio exceeds unity, substantially all of the FeO in the slag appears to be "free," and accordingly is active in controlling the FeO in the metal and the desulphurizing power of the slag.

The value of the sulphur distribution coefficient shows a slight increase with an increase in temperature. Similarly the equilibrium constant, K_s, increases with temperature. This indicates that the desulphurizing reaction is endothermic and is favored by higher temperatures.

Table 3.—Relationship of the Concentration of Iron Oxide in the Slag to Sulphur Distribution Coefficients.

Basicity →	R = 0.466-0.508			R = 0.914-1.090			R = 1.237-1.418			R = 1.531-1.980		
Treatment	Temp., ° C.	FeO, Per Cent	FeO (Mol Frctn.)	% S_s / % S_m	FeO, Per Cent	FeO (Mol Frctn.)	% S_s / % S_m	FeO, Per Cent	FeO (Mol Frctn.)	% S_s / % S_m	FeO, Per Cent	FeO (Mol Frctn.)	% S_s / % S_m
Oxidized	1575	10.15	0.085	0.230	6.84	0.056	0.308	2.63	0.021	0.692	3.05	0.024	0.694
Silicon deoxidized	1575	3.03	0.025	0.227	3.22	0.026	0.309	1.00	0.0080	0.867	1.03	0.0083	2.715
Carbon deoxidized	1575	....	....	0.406	....	....	7.109	....	....	28.40	....	....	....
Oxidized	1600	12.00	0.100	0.200	5.83	0.048	0.356	2.93	0.024	0.665	2.84	0.023	0.811
Silicon deoxidized	1600	3.75	0.031	0.227	3.00	0.025	0.487	1.19	0.0094	2.043	1.08	0.0088	3.680
Carbon deoxidized	1600	....	....	1.274	....	....	7.123	....	....	40.30	....	....	197.00
Oxidized	1625	12.30	0.103	0.223	5.83	0.048	0.346	2.72	0.022	0.745	2.72	0.022	0.914
Silicon deoxidized	1625	4.55	0.037	0.252	2.96	0.024	0.666	1.36	0.011	2.234	1.14	0.0093	4.292
Carbon deoxidized	1625	....	....	0.338	....	....	....	....	....	19.30	....	....	179.00
Oxidized	1650	12.30	0.103	0.243	5.87	0.048	0.336	2.72	0.022	0.775	2.55	0.020	1.080
Silicon deoxidized	1650	5.36	0.046	0.303	2.90	0.024	0.839	1.38	0.012	2.400	1.22	0.0099	4.776
Carbon deoxidized	1650	....	....	....	....	....	....	....	....	....	....	....	130.00
Oxidized	1675	12.30	0.103	0.263	5.46	0.045	0.350	2.72	0.022	0.805	2.39	0.019	1.210
Silicon deoxidized	1675	6.17	0.053	0.315	2.86	0.024	1.013	1.40	0.014	2.523	1.23	0.0104	5.267
Carbon deoxidized	1675	....	....	....	....	....	....	....	....	....	....	....	....

Table 4.—Relationship of Slag Basicity to Sulphur Distribution Equilibrium Constants.

Temperature	*Part I* Oxidized bath		*Part II* Silicon-deoxidized bath	
Deg. C.	R	K_s	R	K_s
1575	0.539	0.0635	0.479	0.0181
1575	0.933	0.0390	0.909	0.0162
1575	1.250	0.0275	1.372	0.0263
1575	1.617	0.0285	1.531	0.0413
1600	0.488	0.0705	0.381	0.0269
1600	0.914	0.0380	0.953	0.0250
1600	1.332	0.0287	1.237	0.0357
1600	1.668	0.0310	1.584	0.0538
1625	0.508	0.0775	0.381	0.0357
1625	0.914	0.0370	0.971	0.0338
1625	1.312	0.0299	1.264	0.0451
1625	1.635	0.0335	1.584	0.0663
1650	0.508	0.0845	0.502	0.0445
1650	0.914	0.0360	0.971	0.0426
1650	1.312	0.0311	1.264	0.0545
1650	1.635	0.0360	1.584	0.0788
1675	0.508	0.0915	0.502	0.0533
1675	0.914	0.0350	0.971	0.0514
1675	1.312	0.0323	1.264	0.0639
1675	1.640	0.0385	1.584	0.0913

Metallurgical Engineering

CONVERSION

to War Production

NO. 2—SHEET-METAL FABRICATING

Last month we presented a special editorial section on Conversion to War Production, outlining and detailing some of the general conversion problems faced by engineers in the metal industries. As conversion approaches its peak the engineering problems become increasingly those of actual manufacturing and production rather than of planning. *This* month's "Conversion" supplement, therefore, presents some practical descriptive and pictorial material of special interest to plants now involved in fabricating war products out of sheet metal by press-forming, drawing, welding, etc.

The first article continues the "Practical Pointers" series started in May (page 776), and describes the best practice in the forming and welding of aircraft exhaust manifolds. It is followed by a pictorial description of the sheet-metal pressing and finishing operations involved in fabricating shatterproof oxygen cylinders for high-altitude aircraft, with the *conversion* background well brought out.

—THE EDITORS.

Practical Pointers on Operating Problems

Fabricating Stainless Exhaust Manifolds

This month's "practical pointer" for harassed war-product manufacturers is a particularly knotty problem that seems to be giving many subcontractors a lot of headaches—the forming and welding of stainless steel aircraft exhaust manifolds, with a minimum of rejections because of cracks. Mr. Campbell's article, necessarily brief, is actually a check list of points to watch when doing this job. —*The Editors*

by H. A. CAMPBELL

Research Engineer, Solar Aircraft Co., San Diego, Cal.

IN setting up facilities for production of aircraft exhaust systems, the primary problems from the manufacturers' viewpoint appear to be those of raw material, forming methods, and welding practices. The existing attempts at solution of these problems are outgrowths of much experience rather than of any concentrated scientific attack and have been tempered largely by the economic aspects of the market and quality of service results demanded. However, experience with this type of product has indicated the directions in which solutions may be sought and expected. (This discussion will be confined to fabrication, since design and engineering problems cover too much territory for the space available.)

Exhaust manifold systems are made usually from chromium-nickel steels within types 321 (titanium-bearing 18-8) and 347 (columbium-bearing 18-8) analyses, and also from high-nickel base materials such as 79-80% Ni, 13% Cr, 6.5% Fe. No conclusive evidence of superiority of any one of these materials over the others has appeared in the literature and all seem to be used with varying degrees of success, for this class of service. From the practical standpoint, type 321 steel and the nickel-chromium-iron alloy work-harden at about the same rates, while type 347 work-hardens at a higher rate.

Any of the conventional methods of sheet-metal forming may be applied: Drop-hammers, toggle-presses, and hydraulic presses are all usable. Drop-hammers offer some advantages in terms of first cost and upkeep, but time, patience, and careful application are required to develop the required individual skill in the operators. Where factory conversion is under consideration, one or the other of these tools is likely to be available now.

The dies may be made from the zinc alloy used generally in the aircraft industry, or nickel-iron and steel punches and dies may be used depending upon the tooling and production economics of the particular manufacturer. Allowances should be made in the punches and dies for spring-back of the wrought steel, otherwise distortion and poor fittings of mating parts will occur. Intermediate annealing treatments will eliminate difficulty with work-hardening of stampings.

There are a number of pitfalls in processing these materials which are likely to cause trouble and resultant loss. Steel surfaces must be quite clean, and free of lubricants or carbon before entry into the furnace. Dies or punches made from zinc alloy often leave particles adhering to the steel sheet blank or form. It is essential that such particles be completely removed, for as little as 0.01% zinc will cause spider-web cracks during and after annealing. Ordinary pickling will serve for removal of the zinc.

For best results a conveyor-type furnace is desirable. Atmospheres should be held neutral. Where batch-type furnaces must be used, pieces should be stacked carefully so that heating is uniform, with pieces not in intimate contact. Careless handling will cause distortion.

Any of the commercial manually-operated methods of welding are applicable to manifold manufacture, as is also resistance-welding, either seam or spot, depending upon the specific construction involved. Rods and fluxes conforming to the current specifications of the Army and Navy are usually used.

Columbium-bearing rods are used for welding the type 321 steels as there is not as great a loss of columbium from the weld during the welding operation, as there is of titanium in titanium-bearing rods. Instructions are issued by manufacturers of welding apparatus as to control of some of the variables found in arc-welding of these materials, as well as by the stainless steel producers, and it should be consulted. In oxyacetylene welding it is important that the minimum amount of heat be used, that the welding flame be maintained neutral or at least but faintly reducing, and that tacking and welding be done in such a way that thermal expansion effects and locked-up stresses in completed welds do not produce cracks. In many cases a final annealing treatment after welding will be found necessary.

The foregoing outline is based upon some of the extensive literature of the subjects involved. Engineers faced with this general fabricating problem should consult the publications of the steel and alloy producers, the welding equipment manufacturers, the American Welding Society, Jevons's book "The Metallurgy of Deep Drawing and Pressing" (Wiley, 1940), Lucas's book "Press Work Pressures" (McGraw-Hill, 1935), a series of articles by Frey and Kogut on "The Use of Rubber for Producing Sheet Metal Parts" in *Aero Digest* for November and December 1940 and January 1941, and a paper by Dudley on "Control Procedure of Torch Welding in Aircraft" given before the 1942 meeting in New York of the Institute of Aeronautical Sciences.

Making Aircraft Oxygen Cylinders

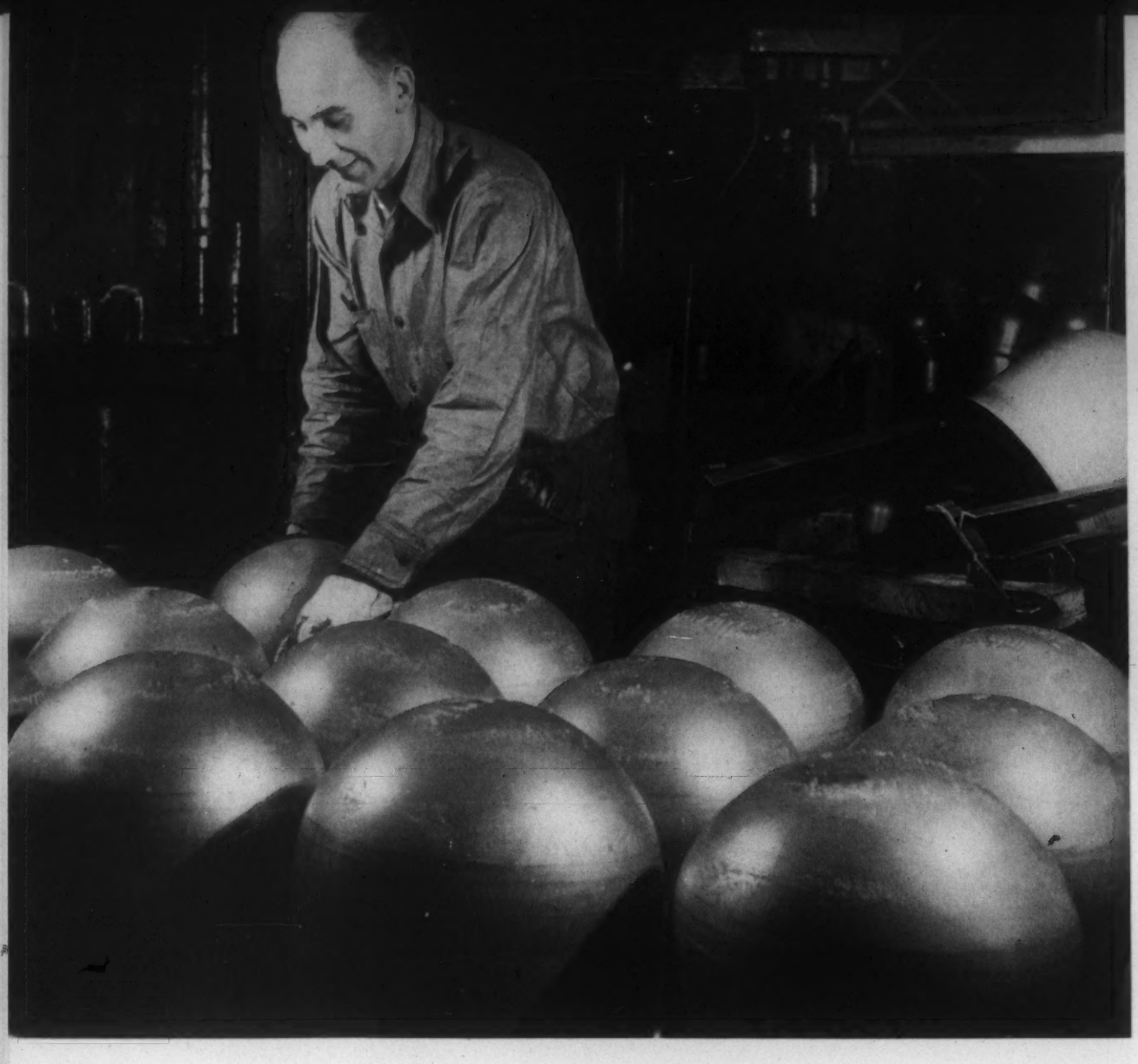
A PICTORIAL "CONVERSION" STORY

The metal department of one of the large American rubber factories has made for some years a type of large metal beverage container. Since this product is hardly essential to the war effort, the company several months ago "converted" to the manufacture of an important war product. This department is now making stainless steel shatterproof oxygen cylinders for use in high altitude flying. New dies were installed in the 750-ton toggle press and other equipment or changes in equipment were made to insure output of the new product.

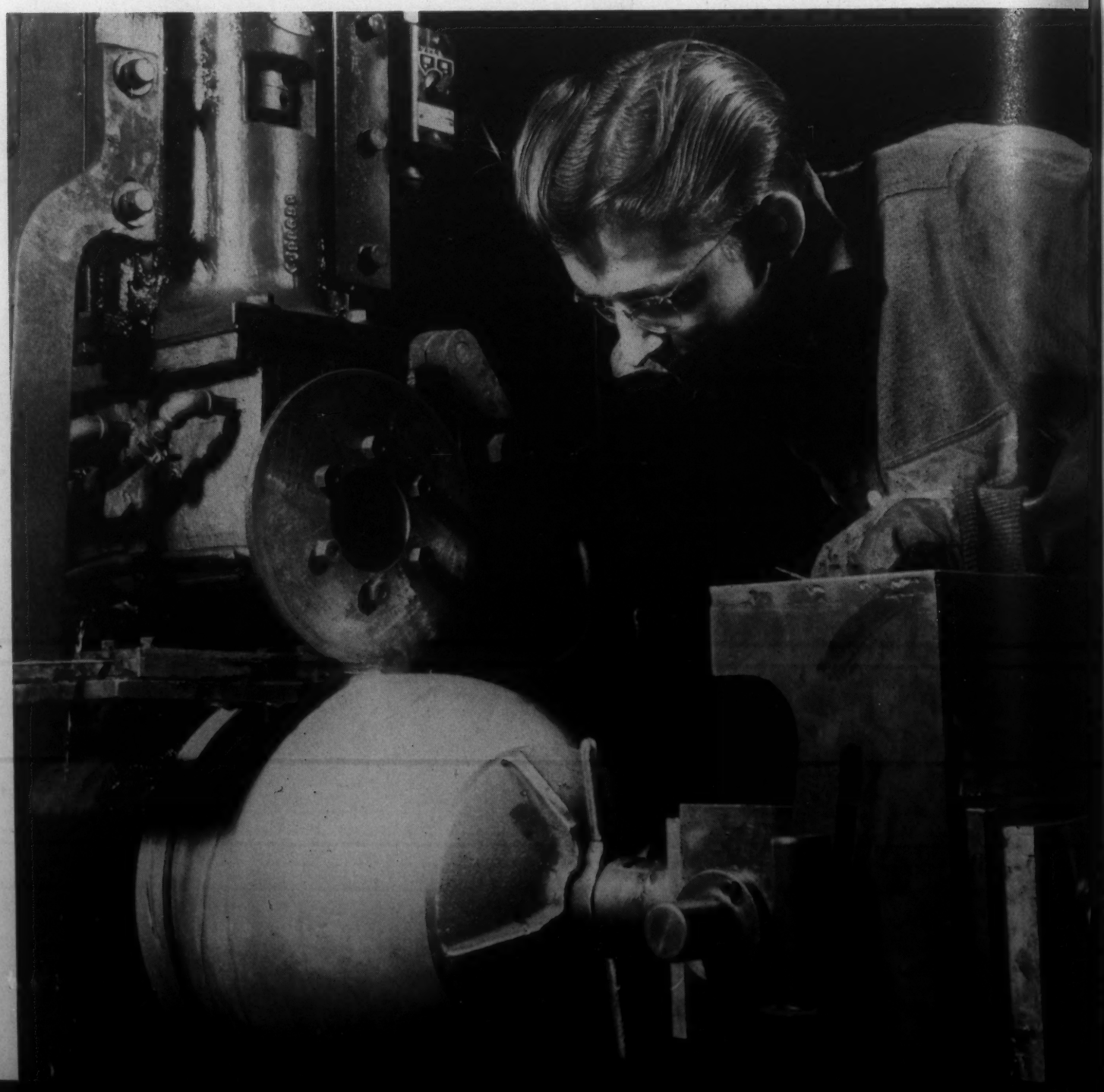
This series of pictures and their captions tell the various steps in making these cylinders. The excellent pictures were released by the Division of Information of the Office of Emergency Management and were photographed by Palmer of that organization.

—The Editors

The first step in the manufacture of high altitude shatterproof oxygen cylinders is the forming or stamping of the shell. Stainless steel sheets are cut into discs which are drawn through rolls where a drawing compound is added to both sides to facilitate the forming of the shell. The 750-ton toggle press, formerly used to form beverage containers, forms a half cylinder in one stroke. It is trimmed and the valve-fitting hole is punched in the spherical dome. The drawing compound is later removed by a cleaning operation.



After the half cylinders are formed, these domes are placed on a large conveyor which carries them to workmen who apply the necessary circumferential and longitudinal straps.



Four major welding operations are essential in the manufacture of these shatterproof oxygen cylinders. In the first one, the circumferential straps are securely welded to the cylindrical portion to prevent tearing of the metal.

After the circumferential straps are welded to the cylindrical portion, rough edges and accumulated weld scale are removed by a skilled workman. The twin rotary brushes, shown in the picture, do their work on the inside and the outside of the cylinder in the same operation.

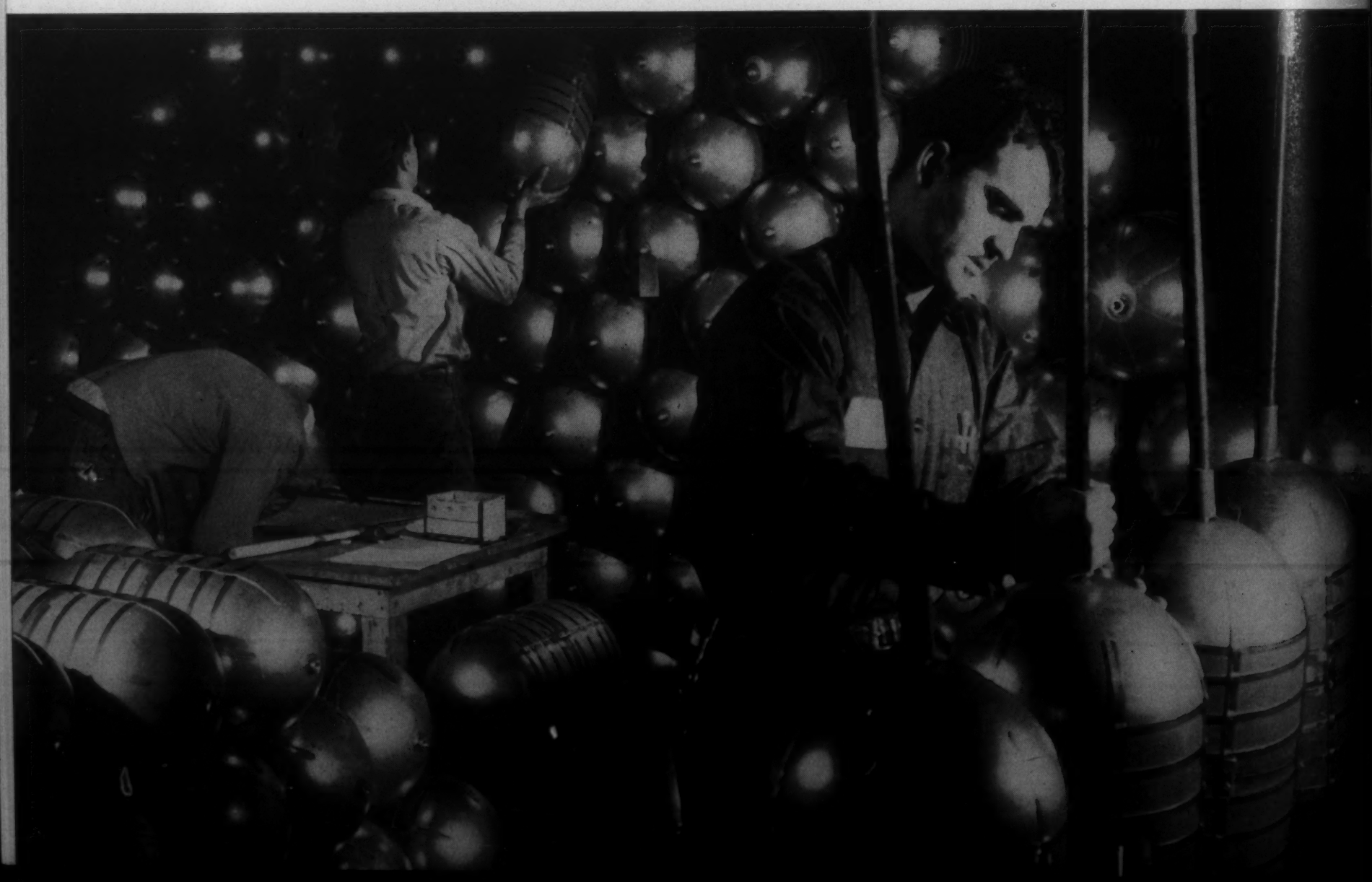
Before completion of the fourth and final welding operation, all straps are subjected to physical tests to determine the strength of the weld. Occasional radiographic inspections are made to insure the quality of workmanship and materials. After the straps are tested, the two halves of the cylinders are brought together in this atomic welding machine and made into one unit. The operator, looking through a specially designed dark safety glass, rotates the shell by sight to insure a perfect and uniform union.

Once the half cylinders are joined together into a complete shatterproof cylinder, all traces of inside weld scale must be removed to prevent contamination of the oxygen. In this process, a special chemical solution is drawn through the cylinder at a controlled temperature and all foreign matter is removed.

Removing from a tank containing a chemical solution a cylinder which has had the treatment for the removal of the weld scale. This bath gives the inside of the cylinder a further cleaning and removes all chemicals which may remain from the previous operation. A satin-like surface, absolutely sterile and free from foreign matter, is made permanent in this operation. The cylinder is now also immune to attack from corrosion and other deteriorating elements.

With the outside and inside of the non-shatterable cylinder complete, several rigorous tests are applied to guarantee safety. Every cylinder is hydrostatically tested at 800 lbs. pressure, twice the pressure maintained in the cylinder under normal use, to test the strength of the welding. It is then given an air test at 400 lbs. pressure as shown in this illustration. Here an attendant is placing a cylinder into a steel compartment filled with water before the pressure is applied. By means of a hand crank, the inspector rotates the cylinder while it is under pressure inside the compartment for a thorough inspection at all points.

After the cylinders have passed all tests, hot air is blown through the cylinders to remove all traces of moisture (left). The cylinders are then sealed (right) and piled into stacks for painting (center).



A group of non-shatterable steel cylinders, after passing all tests, and ready for shipment to the U. S. Army.

Editorials *(Continued from page 955)*

grain is essential for good low temperature impact behavior of any steel, be it converter, open-hearth or electric. These fundamentals were clearly brought out in 1934 by Herty and McBride.

One very large commercial application of Bessemer steel is in seamless pipe, where, as is cited in the 1941 A.S.T.M. report on impact and other properties at sub-atmospheric temperatures, a normalized 0.15 per cent C Bessemer pipe, in 8-in. and 10-in. O.D., 0.5-in. wall, gave 50 ft. lbs. Charpy at room temperature, 42 at 32 deg. F., 36 at 0 deg., 34 at —25 deg., and 20 at —50 deg.

Similarly, the low temperature notched bar impact of cast steel is not a matter of how you melt it, but of how you finish it, so that properly handled converter steel will show better low temperature behavior than less intelligently handled electric.

The name "converter steel" is even affecting the thinking of some people concerned with production of synthetic scrap, where the cupola-converter combination, so quickly and cheaply installed in comparison with other methods, is a life saver in the present need for scrap or its equivalent, and for prompt increase in output.

The situation is quite analogous to an airline wishing to keep its passenger load to a certain limit, say 175 lbs. as the maximum without an excess fare. An Episcopal weighing 200 lbs. being the first Episcopal passenger, and taken as an example, subsequent Episcopals are charged for 25 lbs. excess weight, instead of weighing the actual passenger. However, the steel specifications present a worse situation, they won't even let a 125-lb. Episcopal ride at all. No one can object to wanting the steel in a tank or a gun mount to stand shock in winter weather, but throwing out good steel on its name and refusing to evaluate it on its properties is not a nice way for Washington purchasing authorities to treat a country that needs more tanks and more gun mounts.

Where we need low temperature toughness, why don't we test for low-temperature toughness? It's not a difficult thing to do.—H.W.G.

LETTER TO THE EDITOR

"What To Do With Tin Pots"

To the Editor: Your editorial in March issue, "What to Do with Tin Pots," seems far fetched. The thing to do is keep them in use. Tin will not only go back to 30c, but below 20c again. Look back at 1932, then think of competition between Straits and Texas City tin, lowered demand, the difficulty of ousting silver-solders and silver babbits, if "free" silver becomes a democratic institution, instead of a subsidized industry. Silver at 35c per oz., present imported price, instead of $1.29 for treasury use (which *Am. Metal Market* calls pure swindling) or if the seigniorage silver is freed or sold at the 58c difference in price between $1.29 and cost, or just "given away" by WPA magic to stimulate use of silver, tin will have a difficult time, just as silk would now have, after the Japs killed the market for their biggest export article.

Electro tin coating on steel is far from perfection in its present stage. The none-too-ductile iron-tin alloy of dip tinning serves a very useful purpose where soldering of side seams, ears, lugs and nozzles is needed and at least in one field is very essential and that is the field of evaporated milk cans, where both ends and a side seam need thorough soldering. The open top can is too unsanitary for the purpose, during storage, transit and handling. The very small filler opening (0.113 in. dia.) is the only opening before filling and capping. Coupled with requiring quite a bit less tinplate, shipping space and other economic factors, it serves the industry very well. Electro tin coatings coupled with resistance, induction or oil bath heat treatment may result in coatings of good soldering quality, adapted to low tin solders, with silver and lead, but until a commercially practical process is proven, the old tinpot and all its faults will be a welcome member of the old guard society of can makers.

Yours truly,

Oconomowoc, Wis. W. H. BROOKS

This representative of the old guard assumes that there will not be "a commercially practical process." There has got to be, because "there ain't gwine to be no mo' " tin for some time, and the evaporated milk can with its lavish use of tin and solder is the outstanding case where something has to be done quickly and where old guard ideas will have to be replaced by ideas more responsive to present conditions of shortage.

We have faith that the efforts of progressive can makers who lost their old guard ideas on Dec. 7 and whose efforts are already pretty well over the hump, will meet full success.

As to what will happen when 20c tin is available, we don't think the can maker, who pinches off every possible fraction of milk in the cost of a can, is going to go back to hot dipped stock, with its thick and thin patches. We'll be very happy when the prophecy of tin under 20c becomes a reality, but whether the thick patch is of 20c or 52c tin, it doesn't do any good, and even 20c tin will be worth saving.

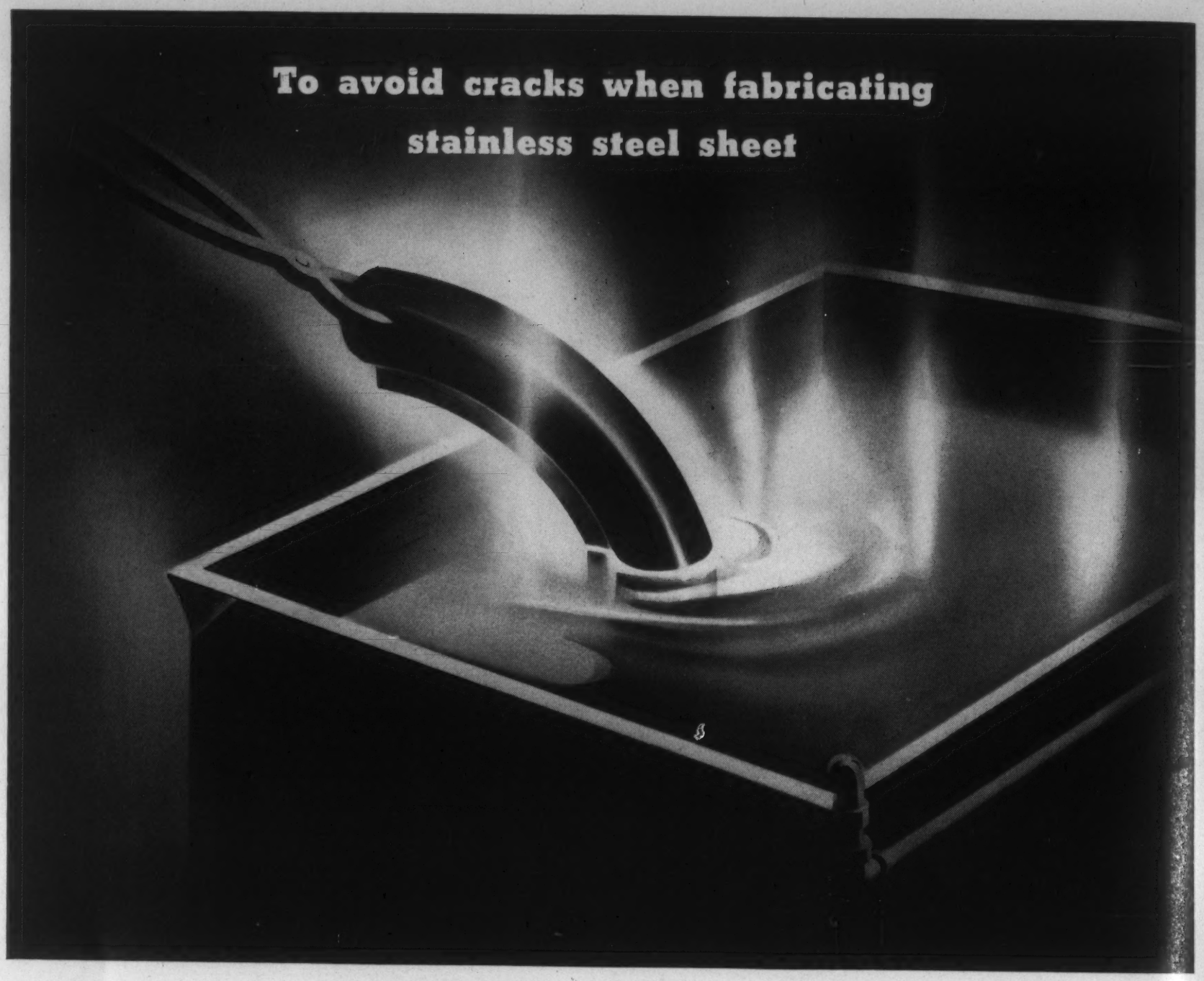
It so happens that milk can be packed in sanitary cans that avoid the need for soldered ends. It is an unfortunate happenstance that the milk industry is not generally equipped to use the sanitary can, for this lack is making a large drain on our scanty tin supply. —H. W. G.

In the plants—in the tanks . . . U. S. Army tanks, rolling and rumbling to defeat the attackers of America, protect their crews against slipping and falling accidents with "A. W." Rolled Steel Floor Plate. It's the same skid-proof safety that speeds production wherever men work. With "A.W." Floor Plate, there are no slippery surfaces. Fire-proof, crack-proof.

ALAN WOOD STEEL COMPANY

MAIN OFFICE AND MILLS: CONSHOHOCKEN, PA. District Offices and Representatives: Philadelphia, New York, Boston, Atlanta, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, St. Paul, New Orleans, Pittsburgh, Roanoke, Sanford, N. C., St. Louis, Los Angeles, San Francisco, Seattle, Montreal.

Photo by U. S. Army Signal Corps



Information supplied by "Metals and Alloys"

For troubles with cracking in formed and welded assemblies made from stainless steel sheets:

1 — If forming is done on drop hammers using soft-metal dies, the formed part should always be pickled before annealing. This removes any zinc picked up from the die, and eliminates the formation of brittle zinc-iron compounds in the sheet during annealing. The presence of such compounds on the surface may lead to cracking during subsequent welding or forming operations, or in service.

2 — Excess acetylene flames should be avoided during gas welding. The carburizing action from such a flame tends to make the steel brittle and subject to cracking under stress.

3 — Carbon arc welding should be used only with the greatest caution, because of the possibility of carbon pickup. Metal-arc welding is a safe form of electric welding for stainless steels.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
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METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products

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Forged Cylinder Heads for Airplanes

A new forged cylinder head, developed by *Wright Aeronautical Corp.,* Paterson, N. J., will allow a 12 to 15 per cent increase in power output of an engine without increase in weight, states Myron B. Gordon, vice-president and general manager. Superiority for the United Nations over present combat aircraft in speed, altitude, load and range is claimed.

The new head effects a 40 per cent saving in material rejection and releases foundry equipment to turn out other parts.

Claims are that the forged cylinder head provides a service engine weighing less than one pound per horsepower. The strength of the new heads, achieved through finer and uniform grain structure of metal, permits much higher compression ratios. The forged head has withstood hydraulic pressure double that of cast heads now in use.

To fabricate, aluminum bar stock is extruded then pressed in a die to final shape. Fins are cut by high-speed milling machines, providing better cooling in addition to the 35 per cent increase in the conductivity of the metal. Improved cooling aids in desert and tropical warfare.

Special machines for cutting the fins have revolutionized the technique of milling, the cutting speeds approaching woodworking operations. Waste is light in forged head manufacture, with 95 per cent satisfactory against 80 per cent in cast heads.

Moved To Larger Quarters!

"The Production Front" has outgrown its former space in this department and now occupies premises all its own in the front of the magazine—starting on page 907. Read it for the things you need to know about war-production policies and trends.

Carbide-tipped Rifle Drills

After experimental runs resulting in an increase of 1/3 to 1/2 in output of drilled gun barrels per man hour and machine-hour Carboloy-tipped rifle drills for 30 and 50 calibre and 20 mm. gun barrels have been placed in production by *Carboloy Co., Inc.,* Detroit. The finish is said to be definitely smoother than with conventional gun drills and with the hole straighter.

The Carboloy tip is brazed to a short steel shank, in turn attached by users to their regular gun drill tubes. Final cutting edges are ground by the individual user. There is claimed an average of some 2 doz. 50-calibre barrels per grind of the tip, with an average of 12-18 barrels per drill per shift.

The life of Carboloy drills is reported to be 3 times that of steel drills. With carbide one removes only 0.010 in. per grind as against 0.030 for steel. In case of breakage the barrel may be reclaimed. Usually a steel drill breakage means freezing of the drill in the barrel, with loss of the latter.

● A new hand-wiping safety solvent, a replacement for naphtha, gasoline and kerosene, for use in ordnance factories, is produced by the Curran Corp., Malden, Mass. Makers claim it does not de-oil the skin, has no toxic vapors, no flash or fire point and leaves an invisible rust preventative film.

(More News on page 992)

For manufacturers of

Stainless Steel Electrodes

Foote Pariflux

(Calcium Fluoride)

and

Calgran

(Calcium Carbonate)

1. Graded in particle size to materially reduce drying cracks.

2. Produced from a selected raw material to insure low reactivity with sodium silicate.

FACTORIES — Wyndmoor, Pa. — Philadelphia, Pa. — Exton, Pa.

Foote Mineral Co.

Sales Office — 1614 Summer Street, Philadelphia, Pa.

"Lost in the Day's News"

The life of the engineer is comparatively prosaic. He is not a glamour boy in the public eye in the sense of Bing Crosby. All the more outstanding therefore is the novel, whimsical and altogether human manner in which Robert C. Onan, Lindberg Engineering Co., Chicago, has been announced as being appointed district sales manager for the Northern Illinois, Iowa, Wisconsin, and Minnesota territory with office at 606 West Wisconsin Ave., Milwaukee. Under the heading: "Lost in the Day's News," Mr. Onan is dished out to the public, in part, as follows:

Mr. Onan was advertising manager of the firm he now represents, but this should not be held against him. He was a good advertising executive . . . honest and sincere in his appraisals, straightforward in his thinking, and broad in his views, even if he didn't like getting on the business end of a pair of tongs, which he can do, if pressed. He is the father of the printed *Heat Treating Hints* and the author and director of the movie of the same name.

Some of Milwaukee's citizens were asked if they knew Onan and what they thought of him. The answers were revealing:

The Mayor: "Oh, him?"

Newsboy on the corner: "De guy's okay, I guess. He don't buy no papers from me. I don't tink de guy kin read."

Building Manager at 606 West Wisconsin Avenue: "Do I have to answer?"

Charley Grimm: "Say, he's a great guy. Many's the good times we've had together, Joe and I . . . huh? . . . Onan? . . . no, I don't know him. I thought you said Cronin . . . Joe Cronin."

And so it went, all Milwaukee agog over their adopted son. Each eager to tell all about this mighty little man who is as busy as a ping pong ball and as thorough as a Saturday night bath.

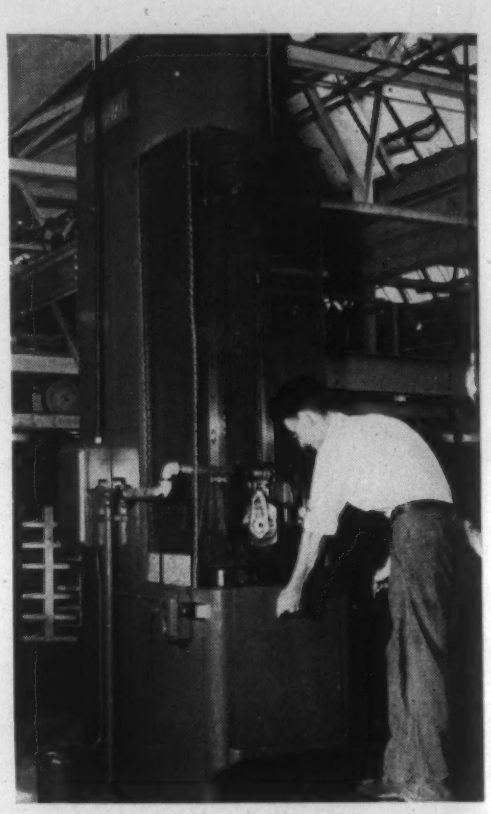
Trapped in a revolving door, Bob Onan revealed: "I like these doors. They remind me of the Super-Cyclone's 100% forced convection heating principle." As he turned to go to his office at 606 West Wisconsin Avenue, he said: "If ever you need any heat treating help, phone Onan, Daly 4668."

● "Industrial Finish Flash-off" eliminates weld spatters. The operator applies the material along the edges of metal surfaces to be joined. When welding is done metal chips bounce off instead of adhering adjacent to the seam, thereby eliminating the need for subsequently grinding or scratching them off. The material is made by *Acme White Lead and Color Works,* Detroit.

● *The Bristol Co.,* Waterbury, Conn., has developed a new radiation pyrometer for recording, indicating and automatically controlling temperatures in furnaces and kilns above 900 deg. F., known as the Pyrovac.

Broaching vs. Milling in Aircraft

"Senior" broaching presses, made by the *Colonial Broach Co.,* Detroit, are used in unusual ways in producing 9-cylinder R975-400 h.p. radial aircraft engines for tanks and training planes at Continental Motors, Detroit. The presses are equipped with special fixtures incorporating broach guide bars for extreme accuracy of alignment. Thus the surface broaching of four flats on the flange of each cylinder by a



10-ton, 42 in. stroke Senior press is considered an outstanding development, performed much more rapidly than by milling and with greater precision.

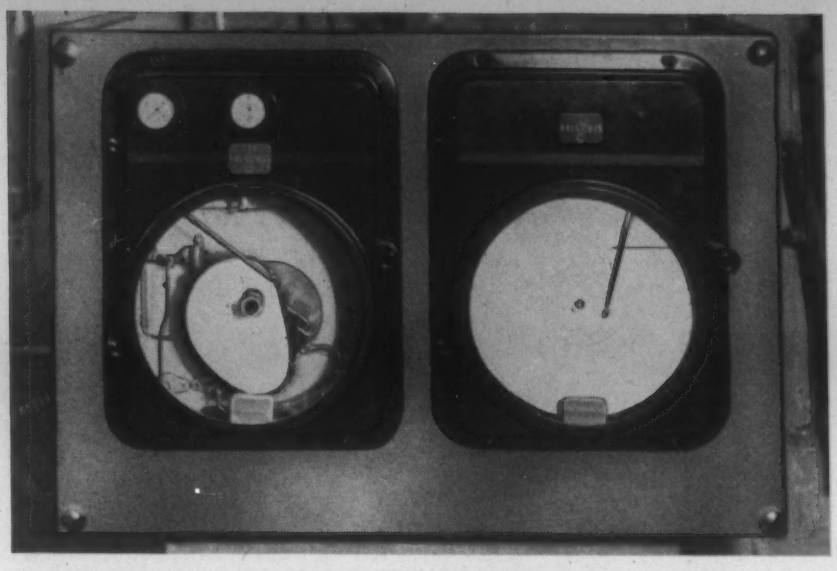
Another unusual application is in slotting a special packing nut, using a 3-ton, 24 in. stroke press, an operation usually done by gang milling. The Senior press is also used for broaching on the fuel pump drive gear.

Alkaline Copper Plating Process

A new plating process that is significant because of nickel shortage is the Unichrome Alkaline Copper Process which gives a fine-grained, smooth copper deposit, even in heavy thicknesses. The plating bath is a mildly alkaline bivalent copper solution, operated at a pH of about 8.5 electrometric. Chemicals are specially prepared and readily available salts, no cyanide. Cost of the bath is around 80c per gal.

The bath is operated at 100 to 140 deg. F. Current densities from 20 to 40 amp. per sq. ft. at a tank voltage of 1 to 2 volts are used normally. Cathode and anode current efficiency is 100 per cent. The process is sponsored by United Chromium, Inc., 31 E. 42nd St., New York.

PYROMASTER HELPS CUT STRESS-RELIEF CYCLE FROM 100 to 40 HOURS



After final welding of assembled units, one of the largest producers of electrical goods formerly required 100 hours for stress-relief heat-treatment. Bristol's Pyromaster Time-Temperature Controller made possible a 60% saving in time, by regulating cooling stages precisely according to schedule.

MANY VARIETIES FOR DIFFERENT NEEDS. Actually, Bristol's sensitive, practically maintenance-free Pyromaster is offered in six different top-notch potentiometers — models merely indicating, merely recording, recording-indicating, and controlling in three different styles. WRITE TO 114 BRISTOL RD., WATERBURY, CONN., FOR BULLETIN 507.

TRADE MARK BRISTOL'S REG. U.S. PAT. OFFICE

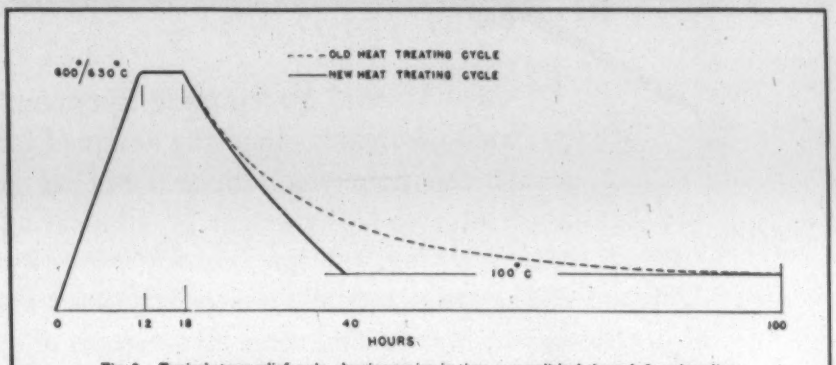


Fig. 9. Typical stress-relief cycle, showing saving in time accomplished through forced cooling

BRISTOL-CONTROLLED HOT BLASTS

Better Pig Iron
Less Labor and Fuel

With hot blast temperatures automatically controlled by Bristol's Pyromaster

- temperature in the smelting zone is made more uniform, maintaining constant quality, unvaried chemical composition of pig iron.
- furnace tender is freed from constant manual supervision, meaning less attention needed for a battery of blast furnaces.
- strains and stresses in blow pipes, tuyere stocks, bustle pipe linings are greatly reduced, lengthening their life, slashing maintenance costs.

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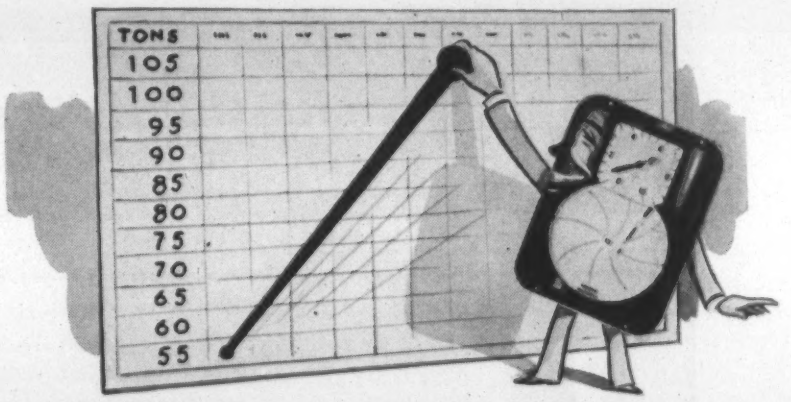

PYROMASTER REPLACES ON-AND-OFF POTENTIOMETER, UPS FURNACE OUTPUT 81.6%

On furnaces for bright annealing steel strip and wire, the on-and-off potentiometers formerly used resulted in widely varying flame length, inconsistent and inefficient heat input in preheating cell, unnecessary stresses on refractories. In place of those potentiometers went a coordinated set of 3 Air-Operated Pyromasters and a Process Cycle Controller.

RESULTS . . . FROM SAME FURNACES

	Tons per week			Average, 3 pairs of weeks
Old control	61	54	59	58
Pyromaster control	112	91	113	105⅓
Percent increase with Pyromaster	83.6%	68.5%	91.5%	81.6%

TRADE MARK BRISTOL'S REG. U.S. PAT. OFFICE

BRISTOL

. . . Gives YOU the Most from Heat

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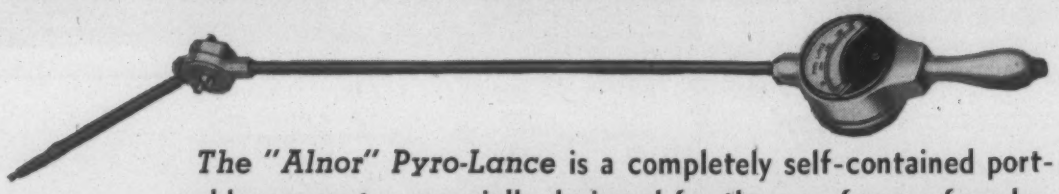
AUTOMATIC CONTROLLING AND RECORDING INSTRUMENTS

Why Hope...

WHEN CASTING NON-FERROUS METALS IT IS FAR MORE ECONOMICAL TO *KNOW* YOUR POURING TEMPERATURES ARE ACCURATE!



The "Alnor" Pyro-Lance **is a completely self-contained portable pyrometer especially designed for the non-ferrous foundry. It can help you reduce costs by lowering scrap losses, cut fuel consumption, speed production by eliminating rejects.**

Rugged, shock-resisting, and low in price, Alnor Pyro-Lance Pyrometers (No. 2980 and 2981) are practically indispensable for determining the molten heat of brass, copper, bronze, and other non-ferrous alloys where temperatures involved are under 2250°F.

For full details and prices, write for our complete "Alnor" Instruments Catalog.

Illinois Testing Laboratories Inc.

Don't Guess Know!

425 N. LaSalle St., Chicago, Illinois

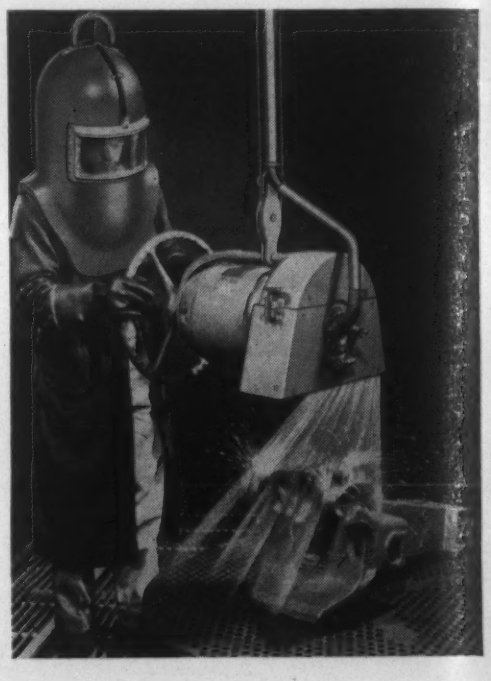
WANTED: TECHNICAL MARKET ANALYST

WELL-ESTABLISHED COMPANY IS IN NEED OF A TECHNICALLY-TRAINED MAN FAMILIAR WITH INDUSTRIAL PRODUCTS AND THEIR MANUFACTURE TO MAKE SURVEYS AND PREPARE REPORTS ON USES AND MARKETS FOR CHEMICAL PRODUCTS, METALS AND EQUIPMENT FOR PROCESSING THEM. SEND ALL INFORMATION, INCLUDING EXPERIENCE RECORD, AGE, MARITAL STATUS, ETC. TO BOX NO. 10, METALS AND ALLOYS, 330 WEST 42ND ST., NEW YORK, N. Y.

● Two new hard-facing alloys have been developed by the *Stoody Co.* Stoodite K is a cast hard-facing rod consisting principally of molybdenum, tungsten, manganese, silicon, carbon and iron. It is good for agricultural tools, cement mill parts, brick and clay equipment, and dredging and excavating equipment. Stoody Self-Hardening K contains chiefly molybdenum, manganese, silicon, carbon, vanadium and iron and is adapted to hard-facing tractor parts, sheepsfoot temper shoes, roll crushers, jaw crushers, gyratory crusher heads, etc. Information is obtainable from Air Reduction Sales Co., 60 East 42nd Street, New York.

Cleaning Intricate, Irregular Work

The portable Wheelabrator, a new blast unit, is said to eliminate such equipment as air compressor motors, pressure tanks, mixing chambers, air receivers, piping, hose, valves and nozzles. Made by the *American Foundry Equipment Co.*, Mishawaka, Ind., it cleans many types of large and small intricate, irregular shaped work, such as handled in jobbing shops. Typical applications are: Lathe beds, flywheels, gears, pulleys, valves, car wheels, frames, housings, etc.



The portable unit is suspended by a cable, connecting with a spring balance for easy height adjustment. The balance is mounted on a carriage free to move on a radial track. Shot or grit is fed to the wheels through a pipe from an overhead storage hopper.

● Probably the least-written-about topic is dust but C. A. Snyder, dust control engineer, *American Foundry Equipment Co.*, Mishawaka, Ind., waxes eloquent on it. On the topic "Why Industrial Dust Control is Necessary" he writes that dust can be a nuisance, a health hazard, can be explosive and can have value (such as in a mint). In a table he gives comparative sizes of dust particles—size in microns, size in inches, screen size and type (tobacco smoke, bacteria, paint pigments, etc.).

TURCO Kwiz Kolumn

FIVE QUESTIONS FOR THE PROCESSING DEPARTMENT

QUESTION: Is it true that magnesium and aluminum, which are similar metals, can be cleaned by the same type of cleaners before processing?

ANSWER: No. In many respects, the two metals have opposite reactions under treatment. Strong alkaline compounds which would attack aluminum, have no effect upon magnesium. Conversely, nitric acid, which will not corrode aluminum, immediately attacks magnesium with almost explosive violence. *Write for Turco Bulletin # A-652 on the treatment of magnesium.*

QUESTION: In War Production, what process is used most often for the surface passivation of aluminum and its alloys?

ANSWER: Anodizing by the Chromic Acid Bath Process. This is an electrolytic treatment.

QUESTION: Why is surface passivation necessary for aluminum?

ANSWER: To protect the metal from corrosion and to form an adhesive surface for paints and other protective coatings. *Write for Turco Bulletin # A-536-A on anodizing of aluminum alloys.*

QUESTION: Is it necessary to clean aluminum thoroughly before anodizing?

ANSWER: Thorough precleaning and final cleaning should always be a part of the anodizing process. While the anodic coating will build from the metal out, beneath minor soils, thorough cleaning is still necessary. *Write for Turco Bulletin # A-642 on precleaning and final cleaning.*

QUESTION: What is Phosphatizing?

ANSWER: Phosphatizing is a chemical treatment for the surface passivation of aluminum and its alloys, which reacts with the metal when applied thereon, to form an aluminum phosphate coating. This coating is a good paint adhesive surface and compares favorably with the longer process of anodizing. *Write for Turco Bulletin # 592 on Phosphatizing.*

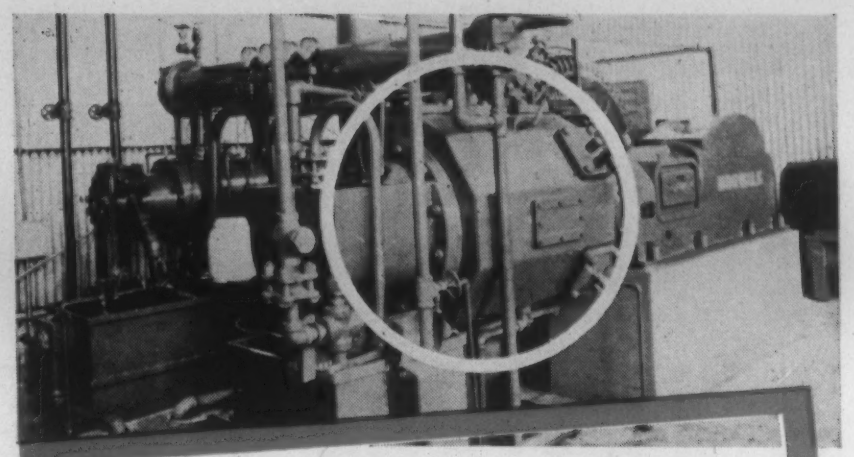
Turco Products, Inc. Manufactures a complete line of Specialized Industrial Chemical Compounds for all of the operations listed below. Check the list and mail in any questions pertaining to them. Full information. Free literature. No obligation.

Factories in Los Angeles and Chicago

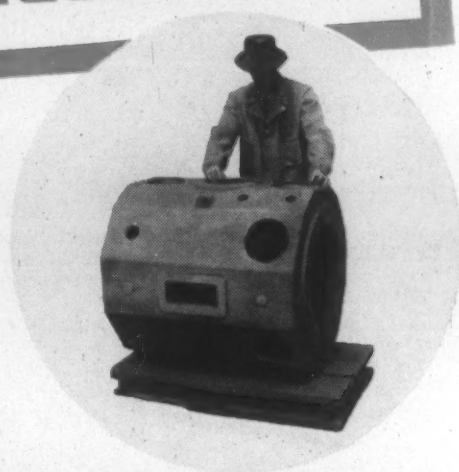
- ☐ Acid Pickling
- ☐ Aluminum Spot Welding
- ☐ Anodizing
- ☐ Cadmium Plating
- ☐ Chemical Vapor Cleaning
- ☐ Chromatizing
- ☐ Cleaning Metals Before Processing
- ☐ Cleaning Prior to Plating
- ☐ Cold Immersion Cleaning
- ☐ Cold Spray Cleaning
- ☐ General Plant Maintenance
- ☐ Glass Cleaning
- ☐ Hot Immersion Cleaning
- ☐ Magnesium Processing
- ☐ Paint Camouflage Cleaning
- ☐ Paint Department Maintenance
- ☐ Paint Stripping
- ☐ Phosphatizing
- ☐ Scale Removal and Control
- ☐ Stainless Steel Processing

28-62

TURCO PRODUCTS, INC.
6135 SO. CENTRAL AVENUE · LOS ANGELES, CALIF.



Pressure Castings Made to PREDETERMINED Physical Characteristics with ABSCO MEEHANITE



take these "made to order" pressure cylinders as a case in point

Norwalk, of course, needs pressure cylinders for varying operating conditions. Pressure castings that meet each of these working requirements are made with ABSCO Meehanite exactly to specification.

The necessary physical qualities . . . such as uniform solidity, pressure-tightness and proper strength . . . are determined before casting. Then, with the positive technical control made possible by Meehanite Selective Processing Methods, our skillful foundrymen turn out pressure cylinders that are right the first time . . . stay "right" in service for years.

You Can Get The Type of ABSCO MEEHANITE Best for Your Castings . . .

Through Selective Processing a type of ABSCO MEEHANITE is available with any of these qualities:

1. **Strength, toughness, high damping capacity**
2. **Ability to stand shock or strain**
3. **Free machining qualities**
4. **Density and Solidity for pressure castings**
5. **Heat, acid and corrosion resistance**

We will be glad to discuss your casting problems with you. Pressure Casting Bulletin No. 10 sent on request.

THE AMERICAN BRAKE SHOE AND FOUNDRY COMPANY
BRAKE SHOE AND CASTINGS DIVISION

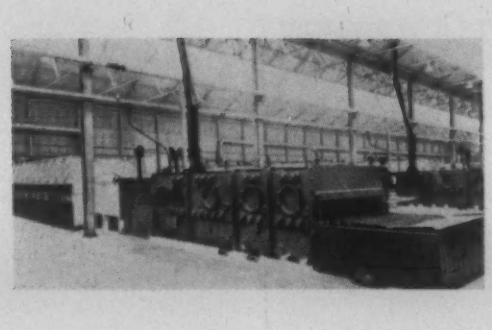
FOUNDRY
MAHWAH
NEW JERSEY

OFFICES
230 Park Avenue, New York, N. Y.
332 South Michigan Ave., Chicago, Ill.

Annealing and Pickling Shell Cases

For equipment for annealing and pickling shell cases *Hanson-Van Winkle-Munning Co.*, Matawan, N. J., has been appointed sole sales representative in the United States for the British concern of Curran Bros., Ltd., Cardiff, Wales. Installations are primarily for brass, but the makers can furnish equipment for steel shells.

One authority says that this new equipment should result in the replacement of the old type of pickling or cleaning tanks and rinses by chambers containing high-pressure jets or sprays. Possibly to be dispensed with are expensive controlled-atmosphere annealing furnaces.



The pickling chamber at the discharge end of a gas-heated muffle furnace provides that articles such as deep-drawn brass cups, can be loaded on conveying mechanism at the furnace mouth and—not touched by hand—emerge annealed, pickled, washed and warmed, drying quickly.

Advantages are: Savings in cost and time, greater pickling efficiency because of the mechanical force of the impinging jets, absence of spray and fumes and saving of acid. Present equipment is for shells 37 mm. or larger. Average pickling time in sulphuric acid is 4 min.

Slants and Plants

Hanson-Van Winkle-Munning Co., Matawan, N. J., maker of electroplating equipment and supplies, is building an addition to its electrical department, an extension to the crane building, 80 by 60 ft., to improve storage and loading of war installations. The electrical department is on a 7-day, 24-hour, 168-hr. per week basis.

About 350,000 lbs. of metal, enough to build more than nine 18-ton Army tanks, has been collected in an intensive campaign at East Springfield plant, *Westinghouse Electric & Mfg. Co.* This campaign was in addition to the plant's year-round scrap program. Workmen searched through workbenches, tool chests and on factory floors, such as for old dies, tools and fixtures not adapted to the war program. Articles were dropped each day into large containers at all factory gates. Sales from the scrap went to the Red Cross. Continuous scrutiny was kept on all tools and fixtures to determine those of immediate value and those to be scrapped.

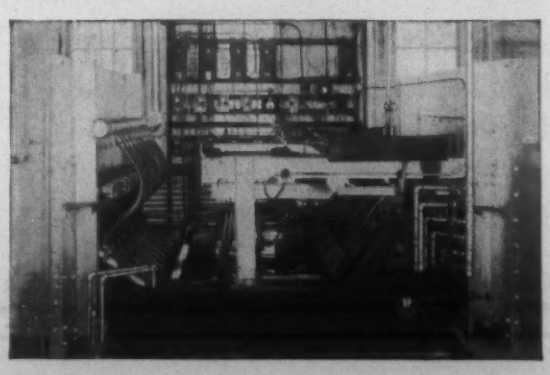
New buildings and equipment, doubling productive capacity of diesel engines, is now being carried out by *Cooper-Bessemer Corp.*, Mt. Vernon, Ohio, at its plant at Grove City, Pa. Two new buildings will allow space for manufacture in what was used for storage. One building, containing four bays, will be integral with the main manufacturing portion of the plant, to be used for storage and shipping. The second building will adjoin the pattern storage building, doubling those facilities.

Perhaps never before have so many production records been made as now. Plants of the *American Steel & Wire Co.* broke 81 more records in April, following 68 in March, making 252 high marks the first four months of 1942. Chicago plants of *Carnegie-Illinois*, another U. S. Steel subsidiary, broke three weekly records the week ending May 9.

EF FURNACES

For Every Industrial Heat Treating Process

These Automatic Gas Fired EF Furnaces Heat Treat Shell - - - Scale-Free



Continuous automatic quenching equipment. The shells are quenched without coming in contact with air, automatically reversed and charged into the tempering furnace at right.

The shell forgings are pushed thru the hardening and tempering furnaces in parallel rows, in protective atmosphere-filled conveying tubes. An automatic quenching equipment (shown at left) is located between the furnaces. The shells are quenched without coming in contact with air, automatically reversed and charged into the tempering furnace. This installation is gas-fired and is equipped with ten conveying tubes. Several similar larger installations have also just been completed.

This is only one of a number of outstanding production furnace installations we have made for heat treating shells and other products such as tank armor castings, machine gun cartridge clips, cartridge cases, aircraft and aircraft engine parts, bomb, gun and ammunition components, and other allied products.

Send for printed matter showing this and other interesting installations.
Submit your furnace problems to EF Engineers.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

Meetings and Expositions

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, summer meeting. St. Paul, Minn. June 15-17, 1942.

EASTERN PHOTOELASTICITY CONFERENCE, semi-annual meeting. Boston, Mass. June 20, 1942.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, summer convention. Chicago, Ill. June 22-26, 1942.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. Atlantic City, N. J. June 22-26, 1942.

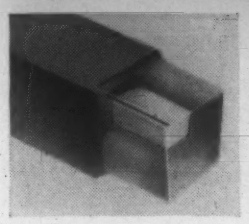
AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention. Spokane, Wash. July 22-24, 1942.

NOT JUST

"How Fast?"

BUT

"HOW FAST *and* HOW WELL?"



You get BOTH SPEED and ACCURACY with KENNAMETAL

In armament plants throughout the country . . . on all types of jobs, KENNAMETAL steel-cutting carbide tools are increasing both machining speeds and accuracy. KENNAMETAL tools machine steels in hardnesses up to 550 Brinell at speeds 2 to 6 times faster than are possible with high speed steel tools—and the greater hardness of KENNAMETAL permits such accurate machining that roughing and finishing often can be combined into one cut.

Find out how KENNAMETAL is increasing production of planes, guns, tanks and ships . . . find out how it can help you in your machine shop. Write for complete information.

KENNAMETAL
THE *All American* CARBIDE

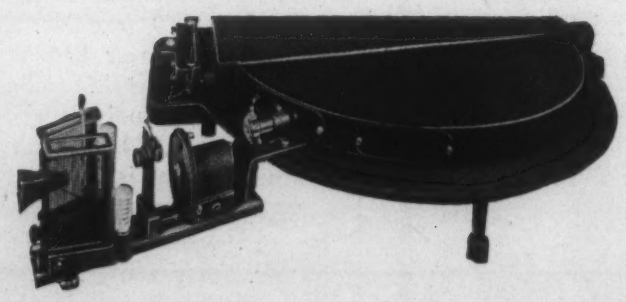
INVENTED AND MANUFACTURED
IN U. S. A.

McKENNA METALS Co.

158 LLOYD AVE., LATROBE, PA.

Foreign Sales: U. S. STEEL EXPORT CO., 30 Church St., New York
(Exclusive of Canada and Great Britain)

SPECTROGRAPHIC ANALYSIS



Exact and rapid analysis of the most complex organic and inorganic materials is easy with the ARL-DIETERT Spectrograph.

Accurate determinations can be obtained rapidly and thus serve as an effective control of the composition of the material as it is being processed.

For detailed information on the ARL-DIETERT Spectrograph and a complete line of mated accessories, write to—

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HARRY W. DIETERT CO.	APPLIED RESEARCH LABORATORIES
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REMOVE QUENCHING OILS FASTER!

Cleaning Heat Treated Parts the Fast, Easy Oakite Way Speeds Subsequent Operations

To clean heat treated parts of rifles, machine guns, small cannon or other ordnance matériel FASTER and better, try specialized Oakite materials. They thoroughly remove tempering and quenching oils... prepare surfaces for grinding, inspection, assembly or other subsequent operations. Oakite war-time technical service is freely available to all concerns... let us help you now!

OAKITE PRODUCTS, INC., 32H Thames Street, NEW YORK, N. Y.
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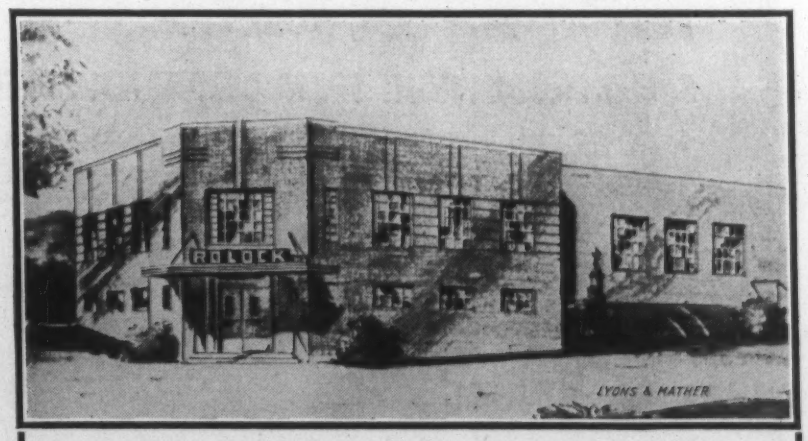
OAKITE *Specialized* **CLEANING**

MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT



We are ready . . . . . .

New and larger quarters for better service on

ROLOCK

INDUSTRIAL BASKETS AND CRATES

for

Annealing, quenching and pickling, brazing, cyaniding, degreasing, anodizing, and other industrial processes.

Send specifications and production application for specific information. Catalog on request.

ROLOCK INC.

1360 KINGS HIGHWAY EAST, FAIRFIELD, CONN.

No-Spray No-Splash Grinder Guards

"Step back!—you'll get all wet," reads the description which continues: "Not so with the new, scientifically designed, Hammond No-Spray-No-Splash concealed guards on the 10-in. and 14-in. wet and dry carbide tool grinders."

Claims are that greater accuracy and much faster grinding operation result because of the extra working area provided around the wheels, permitting maximum light and operating freedom.

The guard is easily rotated from one side of the wheel to the other by a handle, quickly accessible. Model No. 10 is

equipped with 10-in. diam. silicon carbide wheels and Model No. 14 with 14-in. wheels.

The makers are *Hammond Machinery Builders, Inc.*, 1646 Douglas Ave., Kalamazoo, Mich.

Westinghouse Dedicates Its New Merchant Marine Plant

The new merchant marine plant of the Westinghouse Electric & Mfg. Co. at South Philadelphia was dedicated May 22 at an impressive ceremony by Admiral Howard L. Vickery, vice chairman of the Maritime Commission at Washington. In his address, delivered before a large group of Government officials and war workers, the admiral said that "America today has more active shipbuilding capacity than all the rest of the world combined" and that this capacity "is the answer to the Axis dictators."

Admiral Vickery was presented by Ellis L. Spray, manager of merchant marine division of the Westinghouse company who described the record-breaking speed with which the plant was built and equipped for production.

The plant turned out "its first turbine parts the middle of last January, just 65 days after the erection of the first steel columns on Armistice Day, 1941, thus setting a new record. During construction, an average of 200 tons of steel was erected daily, with peak days reaching more than 400 tons. Ground was broken at the tract on Aug. 8, 1941. This beautiful and impressive plant was built at a cost of $26,000,000 with funds supplied by the Defense Plant Corp., and is operated by Westinghouse for the Maritime Commission.

The plant contains 615,000 sq. ft. of floor area and required 12,000 tons of steel. There are 519 machine tools required of which 6 cost over $200,000 each and 45 over $50,000 each. The total cost of machines and tools is about $17,000,000. A total of 2,500 employees will be used when the plant is in full operation.

The dedication ceremonies were preceded by an inspection tour of the plant led by Mr. Spray and A. W. Robertson, chairman of the board of the Westinghouse company, who later addressed the workers and visitors. The company is currently devoting more than 95 per cent of its production capacity to war output and has been converting its plant from normal production since the middle of 1940.

● A liquid coating containing in suspension several mineral substances of which the base has an exceptionally high melting point is advocated by its manufacturer for equipment subjected to temperatures up to 3500 deg. F., such as refractory brick and tubes in parts of furnaces, steam boilers, kilns, nose rings, coolers, etc. The coating, sponsored by *Geo. R. Mowat Co.*, 28 West 44th Street, New York, may be applied by brush, spray, or dipping. Many users report the life of materials doubled or trebled. At high temperatures a porcelain-like glaze is formed by the coating.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

"AMERICA, HURRY!"

Pearl Harbor! Wake Island! Singapore!
BATAAN! MANDALAY! CORREGIDOR!!
Lost--because we sent "too little, too late".

TANKS, PLANES, SHIPS, GUNS, SHELLS AND BOMBS are the sinews of war. If not produced in countless numbers —TODAY AND TOMORROW—THE WAR MAY SOON BE LOST! AMERICA, HURRY!!

***SPEED* PRODUCTION! *SPEED* DELIVERIES! *SPEED* SHIPMENTS!**

★ HOW? Let Pangborn show you. Show you the vital services the ROTOBLAST Barrels, Tables and Cabinets—the Air Blast Rooms, Cabinets and Special Equipment—the Dust Collectors and Control systems are performing for others daily.

★ One ROTOBLAST Barrel just installed replaces twenty-three tumbling mills—and in eight hours cleans more work than the combined mills turned out in twenty-four—and does the job BETTER—at a LOWER COST.

★ A ROTOBLAST Table cuts cleaning time on fragile work 50 percent—ELIMINATING THE WASTE THAT FORMERLY CAME FROM REJECTS DUE TO BREAKAGE AND WARPAGE.

★ A manufacturer of bombs finds it easy to clean the inside and outside of these weapons since he asked Pangborn to help him—AND NOW HIS PRODUCTION IS THREE TIMES WHAT IT USED TO BE.

★ Pangborn technical, sales and research facilities are available to help you SPEED UP PRODUCTION—the benefits of thirty-eight years experience as the World's largest manufacturer of Blast Cleaning and Dust Control equipment are yours for the asking. Use Pangborn help to get MORE OF EVERYTHING MADE OF METAL TO THE YANKS.

THE WAR WON'T WAIT!
AMERICA, *HURRY!!*

PANGBORN

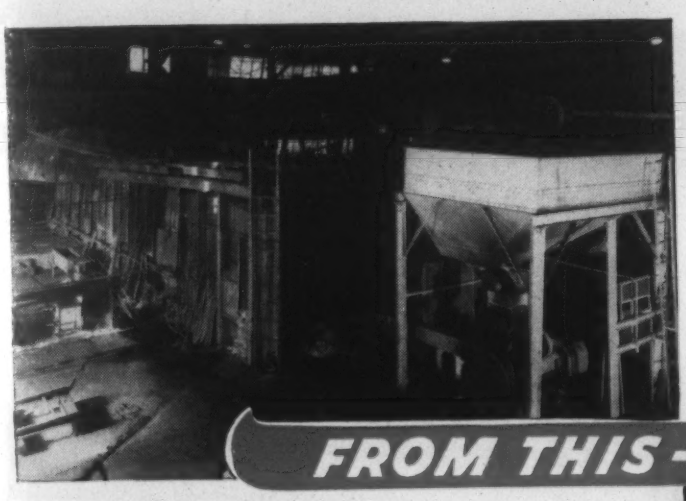
WORLD'S LARGEST MANUFACTURER OF DUST COLLECTING AND BLAST CLEANING EQUIPMENT
PANGBORN CORPORATION . . . HAGERSTOWN, MARYLAND

~~FUEL OIL~~
~~NATURAL GAS~~

TIME IS SHORT!

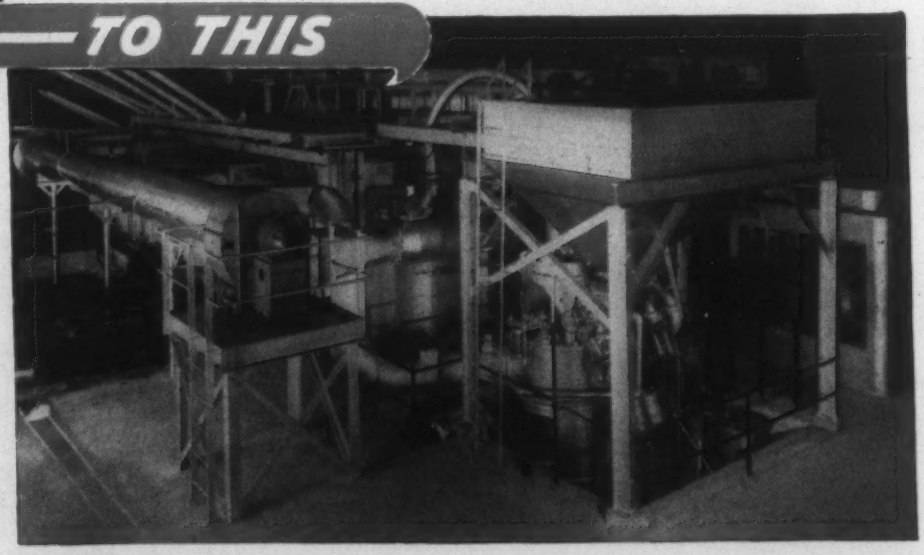
Change to the Victory Fuel

PULVERIZED COAL



TONNAGE INCREASE .. 15%
FUEL SAVINGS 38%
AMORTIZED IN .. 2 YEARS
OPERATION (Automatic Control)

FROM THIS — TO THIS



After changing from an obsolete system to the new AMCO Pulverized Coal System, this installation operated for over a year without the expenditure of a dime for maintenance. This means, in dollars and cents, that the new AMCO Furnace with pulverized coal equipment, was amortized within 2 years.

If you wish further information as to the possibilities in your plant, write us at once!

The Amsler-Morton Co., Fulton Bldg., Pittsburgh, Pa.

Please send us further information and booklet entitled "PULVERIZED COAL, the Victory Fuel."

NAME..... TITLE.....

COMPANY.....

ADDRESS.....

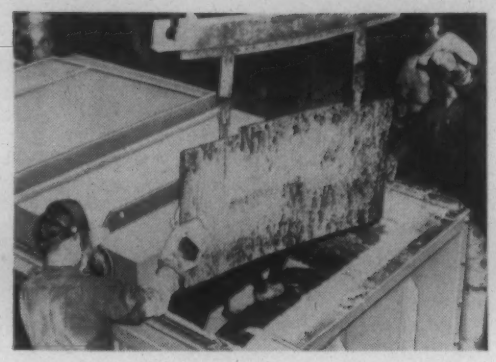
YOU CAN ADAPT PULVERIZED COAL TO YOUR PLANT . . . . why wait .. MAIL COUPON TODAY

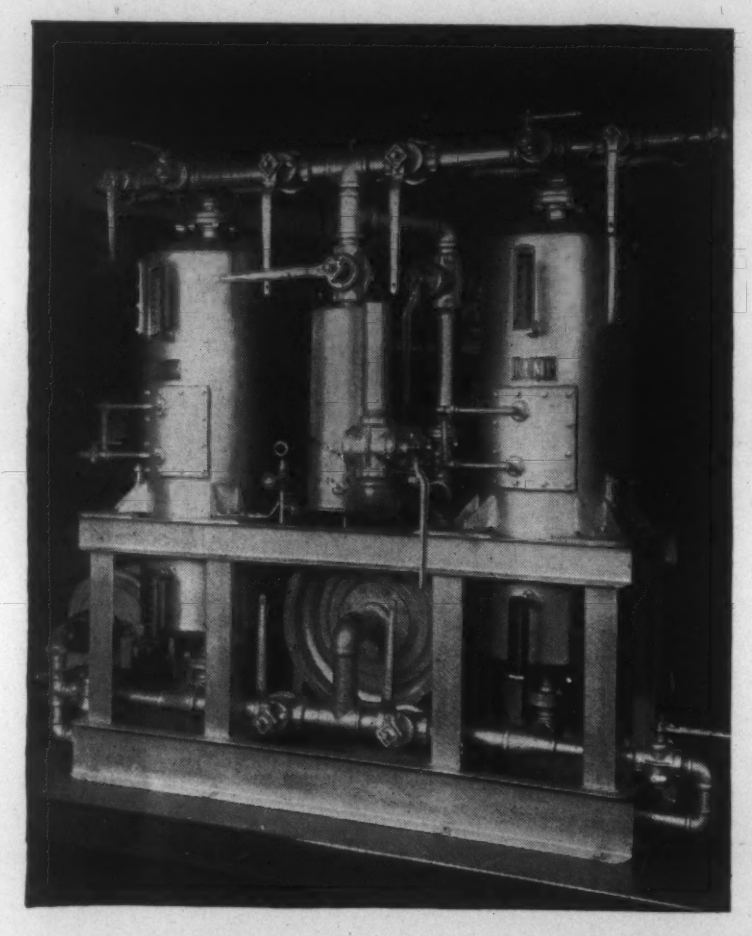
The AMSLER-MORTON Company
FULTON BUILDING · PITTSBURGH, PA.

Deep-case Carburizing by Immersion

A new deep-case electric salt bath carburizing furnace produces cases up to ⅛ in. in depth compared with 0.050 in. formerly considered maximum for immersion. Quenching directly from the bath, or transfer to baths maintained at quenching temperatures, is provided for, thus eliminating the need to reheat for hardening. The process is applicable to tank gears, armor plate, splines, cams, etc.

Utilizing the electromagnetic effect between pairs of closely-spaced electrodes, thus heating while simultaneously circulating the cyanide salts, the furnace, made by the *Ajax Electric Co., Inc.,* Philadelphia, holds temperatures unvarying by 5 deg. at approximately 1750 deg. F.





for

DRY

ANNEALING ATMOSPHERES

KEMP SILICA GEL DEHYDRATORS guarantee the *exact* degree of dryness you need in *your* annealing atmospheres.

Designed by gas equipment engineers; and proven by an impressive record of dependable and economical operation in plants demanding constant and exact drying of annealing atmospheres.

Write **The C. M. Kemp Mfg. Company, 405 East Oliver Street, Baltimore, Maryland—ask for Dryer Bulletin.**

STANDARD UNITS BUILT TO GIVE:
Capacities: 10 to 100,000 c.f.m.
Pressures: Atmospheric to 2500 lbs. per square inch
Adsorbent: Silica Gel, high capacity, long life
Activation: By gas, electricity, or steam, as desired
Types: Single or twin towers for intermittent or continuous operation

KEMP of BALTIMORE

● *Blaw-Knox Co.,* Pittsburgh, believes that it has built the largest ore bucket to date, with maximum load of 25 net tons. With two bites into the ore stockpile it fills a freight car and in seven it charges an 800- to 900-ton blast furnace.

News of Metallurgical Engineers

Charles L. Faust, chemical engineer, Battelle Memorial Institute, Columbus, has been named to a five-year term on the board of managers of the Electrochemical Society, an international group of industrial scientists, the object of which is the advancement of theory and practice of electrochemistry, electrometallurgy, electrothermics, electronics and allied sciences. Dr. Faust is also a member of the American Chemical Society, Phi Lambda Epsilon and Sigma Xi.

Walter Geist has been elected president of the Allis-Chalmers Mfg. Co., Milwaukee, replacing W. C. Buchanan, whose resignation was forced by ill health. At 16 he left school to become errand boy for the Saw Mill Engineering department of the Allis-Chalmers Co. He went through positions of tracer, draftsman, designer and became engineer in charge of transmission, a branch in which he has specialized.

John J. Fitzgibbon became metallurgist for R. Hoe & Co., Dunellen, N. J., on May 11, having left the Whitehead Metal Products Co., New York, where he was foundry engineer.

Charles M. Schoenlaub, who in civilian life was assistant superintendent of the open-hearth department of Republic Steel Corp., Cleveland, has been appointed acting chief of the Production Requirements Branch of the War Production Board. He is now taking over the duties of A. L. Williams, who is ill.

N. H. Brodell has been appointed metallurgical sales engineer of Copperweld Steel Co., Glassport, Pa. He was previously connected with the Timken Steel and Tube Div., Pittsburgh Crucible Steel Corp., and the United Alloy Corp. He is a graduate of Carnegie Institute of Technology.

A. E. Crockett, aged 69, special sales representative for the Jones & Laughlin Steel Corp., died May 20 after a short illness. He had been with the J. & L. company since May, 1915, joining as an engineer. He was primarily in educational work, lecturing before colleges, engineering and technical societies on the manufacture of steel products.

Read

"The Production Front"

Now a separate department on page 907

WAR-PRODUCTION NEWS, TRENDS, FORECASTS

McKAY ELECTRODES . . .

FOR STRENGTH IN ACTION!

Official U. S. Navy Photograph

A ship of the line welded with McKAY Electrodes becomes an *integrated, seamless* hull of continuous steel, with no rivets to burst . . . harder to disable . . . a tough customer in battle!

As McKAY Electrodes SERVE in ship building they also SAVE! Save by materially reducing deadweight . . . save man-power . . . save ship ways by cutting building time in half . . . save millions of rivet holes . . . save vital steel!

The McKAY Company's greatly expanded capacity has been "enlisted for the duration" . . . to SERVE and SAVE wherever the superiority of its "researched" electrode line best functions in the nation's war effort.

THE McKAY COMPANY • PITTSBURGH, PA.

PACIFIC COAST SALES OFFICES: 125 S. Santa Fe Ave., Los Angeles · 100 Howard St., San Francisco

The McKay line includes regular carbon steel, stainless, and alloy steel electrodes for every welding purpose. Literature on request.

The McKay Company was among the first honored with the coveted Navy "E" award for excellence in fulfilling Naval Ordnance contracts.

McKAY WELDING ELECTRODES

AND INDUSTRIAL, MARINE AND AUTOMOTIVE CHAINS

PULLING TOGETHER

Park

SHIPMENTS AS USUAL?

SURE

PARK heat treating products normally are shipped *same* day order is received from you.

Are *You* heat treating shot, bullets, shells, armorplate, etc? PARK metallurgists can help you.

Our Neutral and Reheating Salts are *daily* processing above products *without* decarburization and scale, and meeting government ballistic tests.

1— NUSAL: An Ideal Neutral Salt, Non-Fuming, Producing Scale Free Armament. Melts 1230° F. Workable to 1650° F.

2— 900 SALT: For Lower Temperature Neutral Bath Reheating Medium. M. P. 900° F. W. R. 1650° F.

3— K_3 SALT: Excellent For Salt Bath Treatment of Shot. M. P. 1020° F. W. R. 1700° F.

4— K_{17} SALT: Neutral Hardening Salt. M.P. 1175° F. W.R. 1900° F.

Heat Treating Park Products since 1911

CHEMICAL COMPANY

8076 MILITARY AVENUE DETROIT, MICHIGAN.

METALLURGICAL ENGINEERING shop notes

Immersion Heater Speeds Metal Cleaning

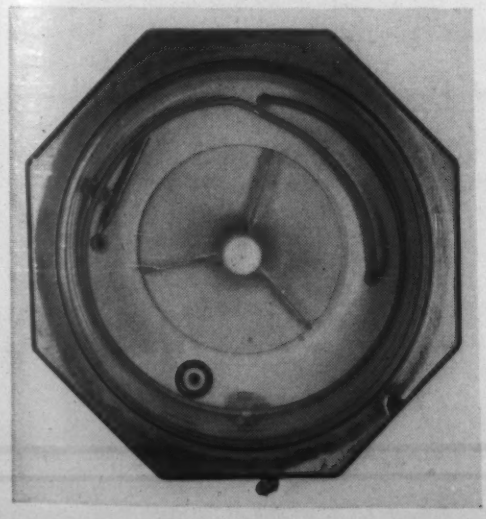
by L. A. Koch
Koch Mfg. Co.

An immersed-heater arrangement for cleaning metal parts more rapidly than is ordinarily possible has been recently adopted in our shop with good results, and a description of it may be of value to others having a similar problem.

After a certain metal specialty we process has gone through the manufacturing process it is cleaned in a liquid soap solution heated to 190 deg. F. Formerly the solution was heated in a tank by gas, but much valuable production time was being wasted because of the excessive time required to bring the solution up to the proper temperature.

To speed the heating of the soap solution we devised what we call a "jiffy" cleaner. Consisting simply of a General Electric 5000-watt, 230-volt Calrod heater looped around the bottom of a second-hand household washing machine, the "jiffy" cleaner brings the solution to the proper temperature eight to ten times faster than by the old method, and has resulted in cooler working conditions, more accurate control of heat, and more economical operation.

The parts to be cleaned are placed in the machine in a special wire rack so that they will not strike the agitator or come in contact with the heater.



View looking down into machine, showing arrangement of the immersion heater. (above)

Rack full of parts being placed in the machine. (right)

Previously, manufacturers showed little interest in applying carbide tools to large machines such as boring mills, large vertical turret lathes, etc. Such machines were rarely run on a continuous basis, were designed for low speed cutting, were low-powered and lacked rigidity. Today production on such machines has been stepped up under war-time pressure. Moreover modern large machines are more rigid and have higher power and speed. Among the advantages of carbide tools on large machines are: Higher cutting speed means reduction in feed, hence better finish; lighter fixtures are permitted; thin-wall parts can be machined more effectively; longer tool life per grind is accomplished; harder materials can be machined; and more work with less effort results.

Carboloy Co., Inc.

Faster Brazing with Silver Alloy

by M. C. Robbins
Handy & Harman

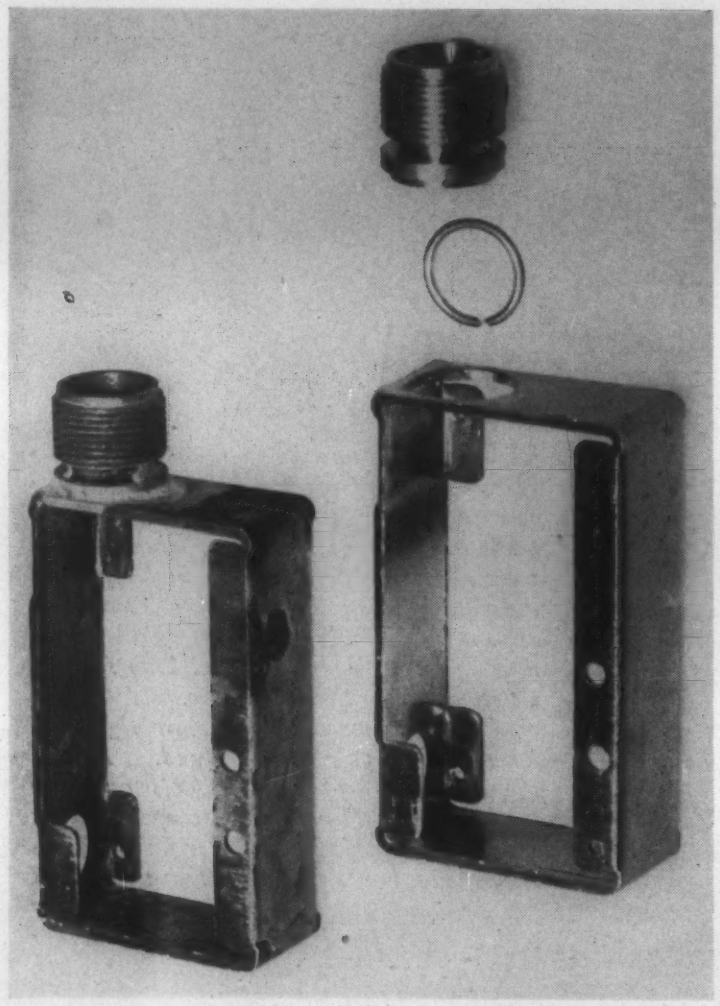
Engineers who are confronted with the need to speed up their brazing practice or to find some satisfactory alternate for hard-to-get base metals may find an adaptable idea or two in the following experience of a manufacturer of switch housings.

In the former practice, a steel stud fitted into a steel box was brazed with a high-melting-point base metal alloy; then, after grinding off excess alloy and cleaning, the assembly was cadmium-plated. At present the base metal brazing alloy has been discontinued in favor of a low-temperature silver brazing alloy. Production immediately increased to 3 times the former rate—from 500 per day to 1500 per day. This not only meant faster deliveries to vital war industries, but also permitted an actual reduction in the price of the switch.

The brazing procedure is simple and no

radical design change was necessary. After the parts are cleaned and fluxed, a ring of brazing alloy is placed between the stud and the box. The assembly is then heated in a gas fired furnace. At 1175 deg. F. the silver alloy ring melts and flows between the parts, forming a leak-tight joint, stronger than any previous method of joining the two parts.

The manufacturer discovered two other advantages. By low-temperature silver alloy brazing, no grinding is necessary after brazing and the joints remain leak-tight, even when replating is necessary. Formerly, when removing the cadmium, then replating, the joint became porous. Now, joining the parts with the silver brazing alloy, this porosity does not occur. These Micro switches are all used for war materials, mostly aircraft.



Easy-Flo ring (at right) ready for placing between stud and box. At left: After heating to 1175 deg. F. the ring has melted and penetrated through parts.

Heat Treating Gun Tubes

The heat treating operation is often a bottleneck in the production of gun tubes, as the forgings can be made much more rapidly than they can be heat treated. Huge furnaces and high vertical quench tanks are necessary.

Government specifications on the 75 mm. gun tubes, for example, call for a minimum and maximum yield strength of 110,000-125,000 lbs. per sq. in., with a minimum reduction of area of 35 per cent—according to the type of gun. No *method* of heat treatment is specified by the Government, the manufacturers being required only to meet the *property* specifications.

Here are two procedures out of several that have been developed for such work:

The heat treatment practice used by one large plant involves a double normalizing process, the forgings being lowered vertically into the furnace where they are heated slowly to 1850 deg. F., held for 8 hrs., then cooled in still air to 500 deg. F. At this temperature they are again inserted in the furnace and heated to around 1650 deg. F., held at that temperature for 6 hrs. and again air cooled.

For the third time the forgings are reheated to 1550 deg. F., where they are held for 6 hrs. They are then removed directly to the quenching tank, the temperature of the oil being between 60 and 70 deg. F. before the quench. The oil is not permitted to rise above 200 deg. F. during the quench.

The tubes are hung in a quenching disc during the heating and quenching operations. They tend to bend slightly but because of the considerable amount of stock which must be removed, very few of them require straightening.

The tubes are removed from the quench at about 300 deg. F. and drawn immediately at a temperature of between 1050 deg. F. and 1150 deg. F., being held at drawing temperature for 10 hrs. This detailed heat treatment develops an exceptionally fine grain structure.

In another case rough bored forgings obtained from the steel mill correspond to the S.A.E. 4340 classification. These are heated at 1550 deg. F., 8 hrs. to come to heat and 8 hrs. to soak.

They are then quenched in oil, breech end down, and reheated to 1475 deg. F., after which they are quenched in water. The tubes are then drawn at 1200 deg. F. and allowed to furnace-cool very slowly.

In considering the oil to use for quenching, many manufacturers are keeping in mind the life of the oil, its stability and uniformity of case rather than buying it on first cost or strictly on the initial physical properties. The quenching operation is based on simple metallurgical principles of heat treatment.

Applying these to gun tubes, it is the practice to withdraw the tube from the quenching bath before it is quite cold, usually around 300 deg. F., thus largely avoiding the danger of cracking and severe warping. Oil provides a fast quench, yet is much less severe than water, and hence preferred.

—War Production Data from *"The Houghton Line."* E. F. Houghton & Co.

In many plants, electrolytic attack by corrosive liquids reduces the life span of aluminum condensers, vats and exchangers. One good way of extending their life today is through cathodic protection—attaching a few pounds of zinc strips or plates to the walls of the aluminum (or other metal) equipment. The zinc is then preferentially attacked, rather than the aluminum, and may be readily replaced (as long as zinc is available for this use). In one case $5 worth of zinc strips extended the normal 2-yr. life of a thousand-dollar tartaric acid recrystallizer to more than 5 years.

—Aluminum News-Letter
Aluminum Co. of America

Welding electrodes are among the most essential pieces of war industry equipment. In addition to the metal in the rod, there are other critical materials in the coating that must be conserved. An electrode can be used the entire length of its coated surface, and leaving any more than a stub end is a waste. Gripping the rod at the extreme end in the holder and burning it down to the maximum extent therefore renders a patriotic service.

—The Stabilizer,
Lincoln Electric Co.

Data on Properties and Working of Free-Machining "KR" Monel

A strong, corrosion-resistant alloy suitable for machining parts which may be hardened by thermal treatment

The new INCO Nickel Alloy, "KR" Monel,* possesses the same combination of properties as "K" Monel.* Equally rustless and resistant to corrosion, it can be hardened by the same treatment to obtain the range of strength, ductility and hardness shown in table below. Like "K" Monel, this alloy is also non-magnetic. However, its machining characteristics are much superior to those of "K" Monel.

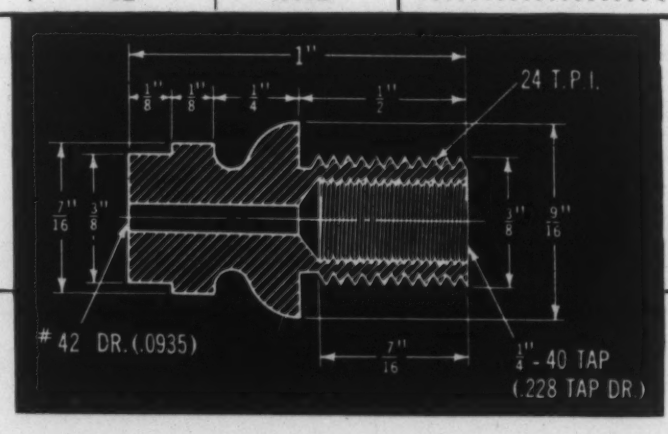
Machining data appear in the sketch and work sheet of operations on a practical job. For more detailed instructions, send for the new, revised edition of Bulletin T-12, "Machining Monel, Nickel and Inconel." Address:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street **New York, N. Y.**

TABLE OF OPERATIONS

Operation	Rev. Per Min. Spindle	Rev. Per Min. Attachment	Surface Ft. Per Min.	Feed Inches	Remarks
Form	560	....	82	.00025	.....
Box Tool	560	....	82	.003	.....
No. 1 Drill	890	....	54	.002	L.H. Drill
No. 42 Drill	890	1600	60	.0015	L.H. Drill Drilling Attachment
Thread	560	308	25	.0416	Threading Attachment
Tap	560	183	25	.025	Tapping Attachment
Cut Off	560	....	82	.0002	.....

Material—9/16" dia. cold drawn as drawn (not age hardened) "KR" Monel
Machine—No. 2 B & S Automatic Screw Machine
Forward speed of spindle—560 R.P.M.
Backward speed of spindle—890 R.P.M.
Tool—high speed steel (18-4-1 Type)
Cutting lubricant—sulfurized oil



"Monel" and other trade-marks which have an asterisk associated with them are trade-marks of The International Nickel Company, Inc.

MECHANICAL PROPERTIES OF "KR" MONEL

Rods and Bars—Cold Drawn	Tensile Strength 1000 p.s.i.	Yield Strength (0.20% Offset) 1000 p.s.i.	Elongation in 2 in. per cent	Brinell Hardness 3000 kg.
Annealed	90-110	40-60	45-35	140-180
Annealed, age hardened	130-150	90-110	30-20	240-260
As drawn	100-125	70-100	35-15	175-250
As drawn, age hardened	140-170	100-130	30-15	260-320

INCO NICKEL ALLOYS

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • NICKEL • "Z" NICKEL

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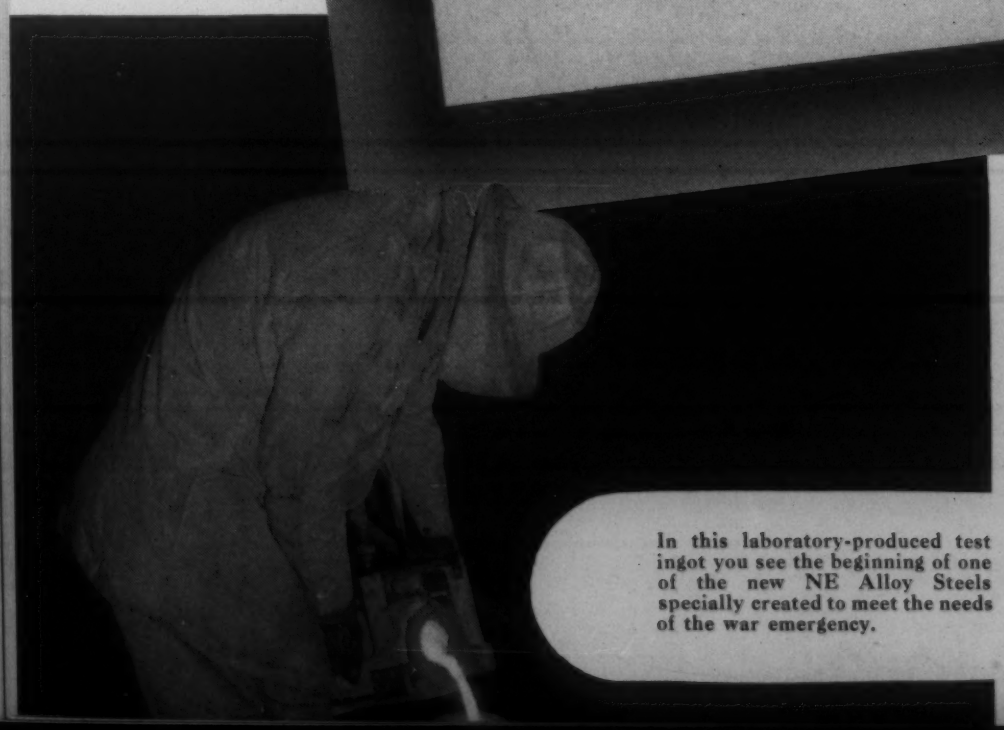
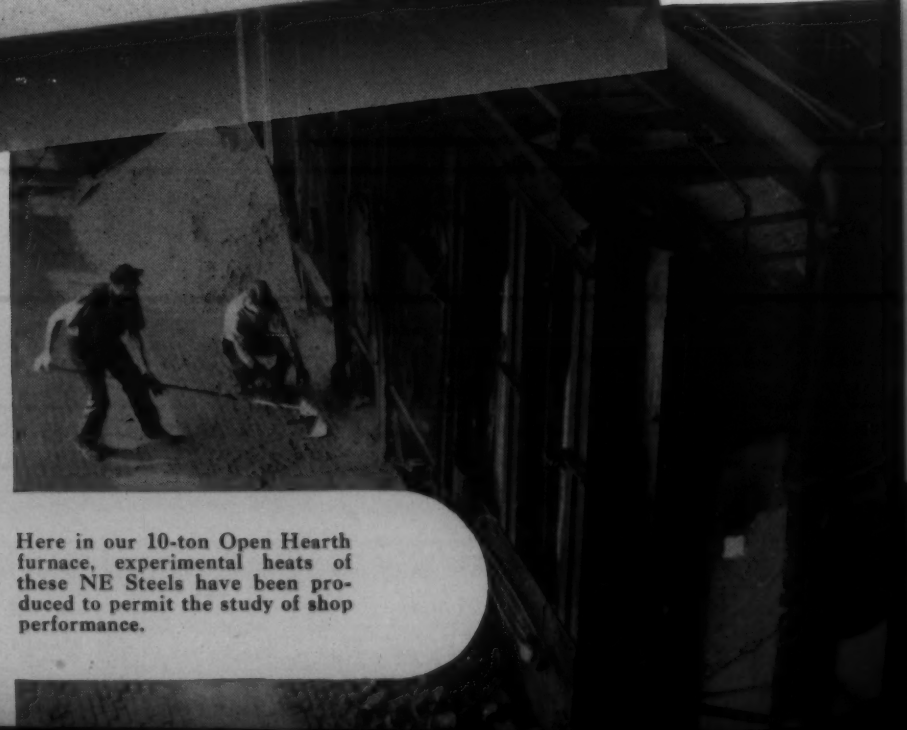
ALTERNATES FOR CONSTRUCTIONAL ALLOY STEELS

Description	C	Mn	Mo	Ni	Cr	Si
NE 8024	0.22/0.28	1.00/1.30	0.10/0.20	.....	.....	0.20/0.35
NE 8124	0.22/0.28	1.30/1.60	0.25/0.35	.....	.....	0.20/0.35
NE 8233	0.30/0.36	1.30/1.60	0.10/0.20	.....	.....	0.20/0.35
NE 8245	0.42/0.49	1.30/1.60	0.10/0.20	.....	.....	0.20/0.35
NE 8339	0.35/0.42	1.30/1.60	0.20/0.30	.....	.....	0.20/0.35
NE 8442	0.38/0.45	1.30/1.60	0.30/0.40	.....	.....	0.20/0.35
NE 8447	0.43/0.50	1.30/1.60	0.30/0.40	.....	.....	0.20/0.35
NE 8547	0.43/0.50	1.30/1.60	0.40/0.60	.....	.....	0.20/0.35
NE 8620	0.18/0.23	0.70/0.95	0.15/0.25	0.40/0.60	0.40/0.60	0.20/0.35
NE 8630	0.27/0.33	0.70/0.95	0.15/0.25	0.40/0.60	0.40/0.60	0.20/0.35
NE 8724	0.22/0.28	0.70/0.95	0.20/0.30	0.40/0.60	0.40/0.60	0.20/0.35
NE 8739	0.35/0.42	0.75/1.00	0.20/0.30	0.40/0.60	0.40/0.60	0.20/0.35
NE 8744	0.40/0.47	0.75/1.00	0.20/0.30	0.40/0.60	0.40/0.60	0.20/0.35
NE 8749	0.45/0.52	0.75/1.00	0.20/0.30	0.40/0.60	0.40/0.60	0.20/0.35
NE 8817	0.15/0.20	0.70/0.95	0.30/0.40	0.40/0.60	0.40/0.60	0.20/0.35
NE 8949	0.45/0.52	1.00/1.30	0.30/0.40			
A 4023	0.20/0.25	0.70/0.90	0.20/0.30	.....	.....	0.20/0.35
A 4024	0.20/0.25	0.70/0.90	0.20/0.30	.....	.....	0.20/0.35
A 4027	0.25/0.30	0.70/0.90	0.20/0.30	.....	.....	0.20/0.35
A 4028	0.25/0.30	0.70/0.90	0.20/0.30	.....	.....	0.20/0.35
A 4032	0.30/0.35	0.70/0.90	0.20/0.30	.....	.....	0.20/0.35
A 4037	0.35/0.40	0.75/1.00	0.20/0.30	.....	.....	0.20/0.35
A 4042	0.40/0.45	0.75/1.00	0.20/0.30	.....	.....	0.20/0.35
A 4047	0.45/0.50	0.75/1.00	0.20/0.30	.....	.....	0.20/0.35
A 4063	0.60/0.67	0.75/1.00	0.20/0.30	.....	.....	0.20/0.35
A 4068	0.64/0.72					
A 9255	0.50/0.60	0.70/0.90	.....	.....	.....	1.80/2.20
A 9260	0.55/0.65	0.70/0.90	.....	.....	.....	1.80/2.20



In this laboratory-produced test ingot you see the beginning of one of the new NE Alloy Steels specially created to meet the needs of the war emergency.



Here in our 10-ton Open Hearth furnace, experimental heats of these NE Steels have been produced to permit the study of shop performance.

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Listed, too, are standard A.I.S.I. steels containing no chromium or nickel, which are also being adopted in this conservation program.

The use of these steels may require changes in established methods of fabrication, or in heat-treatment procedures, or in both. It may even require changes in engineering design. Certainly it will involve careful study in selecting these steels to suit your particular fabricating operations. We are prepared to help you meet this situation with the least dislocation of your present procedure.

It was gratifying to us of Carnegie-Illinois to be called upon to make a major contribution in the development of the National Emergency Steels. But their successful development, we believe, also entails a definite responsibility on our part to assist industry, as far as possible, in *applying* these steels successfully. This we are glad to do—and to the fullest extent of our capabilities.

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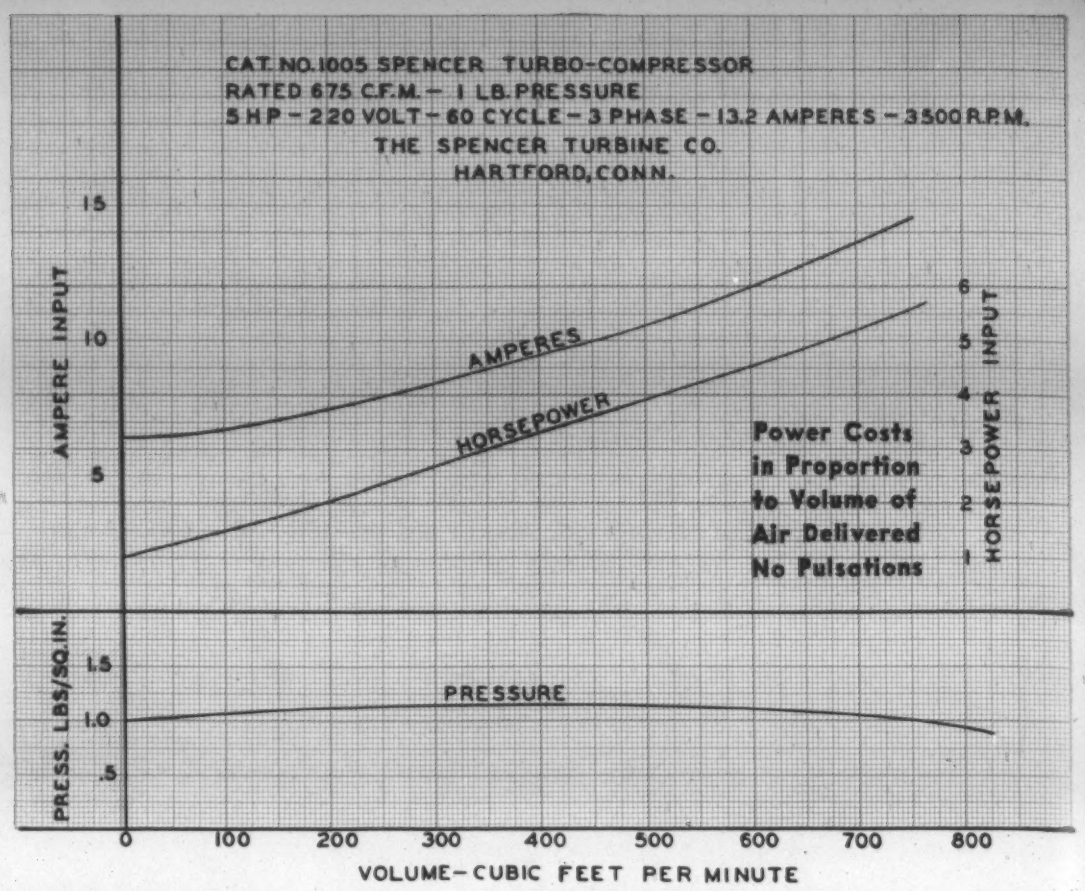

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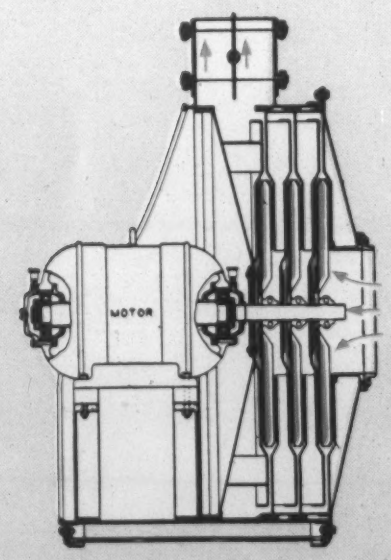

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Resin Binders for Molding Sands

Condensed from an American Foundrymen's Assoc. Preprint

Organic binders are added to molding sands because they help to produce sound castings of better finish. Cereal binders are most commonly added to synthetic bonded steel molding sands, while sea coal is common to iron foundry sands. Pitch is used in both iron and steel foundry dry sands.

The purpose of this paper is to study the effect of resin binder additions on sand properties, and to offer some comparative data with respect to the above-mentioned other organic binders. The effects of other variables in mold-making, such as ramming, drying temperature, air-drying and storage in a moist atmosphere, are also studied.

Resins may be divided into two groups, natural and synthetic. Because of their cost, synthetic resins have not been widely used as a binder for core or molding sands. Natural resins, readily available at a low cost, have found wide usage.

The most abundant natural resins are those obtained from pine trees. Beginning in 1935, there was made available to foundries a pine resin having a character somewhat different from the other pine resins. This new resin was higher in melting point and different from ordinary wood rosin in that it was obtained by extracting pine stump wood with solvents other than gasoline.

This resin was found to be more suitable for use as a dry core binder because of its low ash, high melting point, and higher bonding strength. It can be pulverized readily to the desired fineness to give easy mixing with core or molding sands. When pulverized its melting point is sufficiently high that it can be shipped and stored in powdered form without danger of reversion.

The effect of resin binder addition to molding sand may be summed up as follows: The resin imparts added dry strength to the sand beyond that normally expected from the clay alone. The sand containing resin, when air-dried, will show a higher mold hardness and will reach this hardness sooner. When fully dried, the resin bonded sand will retain its dry compression strength better when exposed to moist atmosphere.

When subjected to heat during pouring, the resin is decomposed, generating an appreciable volume of gas of a reducing character. The resin loses bond rapidly, as shown by hot strength tests. The resin had little effect on the expansion of two sands examined. The addition of resin reduced the tendency of a synthetic bonded sand to crack on shock heating.

These data, determined with new synthetic sands, illustrate the effect of resin binder additions on the properties of such sands. Similar effects are obtained with natural bonded sands.

The same basic effect is obtained with system or heap sands, but naturally, the history of the system or heap is important. In most sand systems or heaps, there will be some carry-over of unburned organic material added. The sand will gradually

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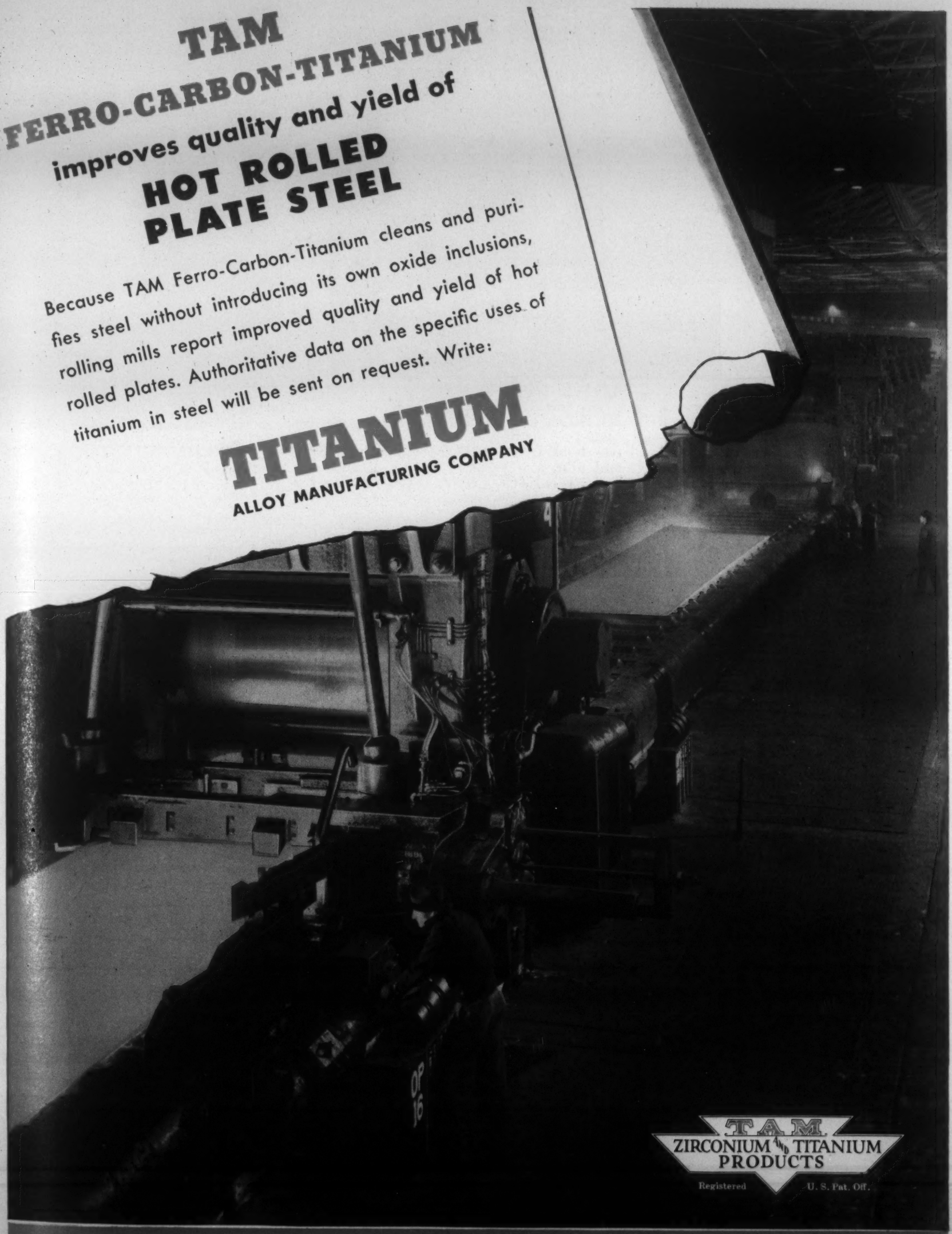

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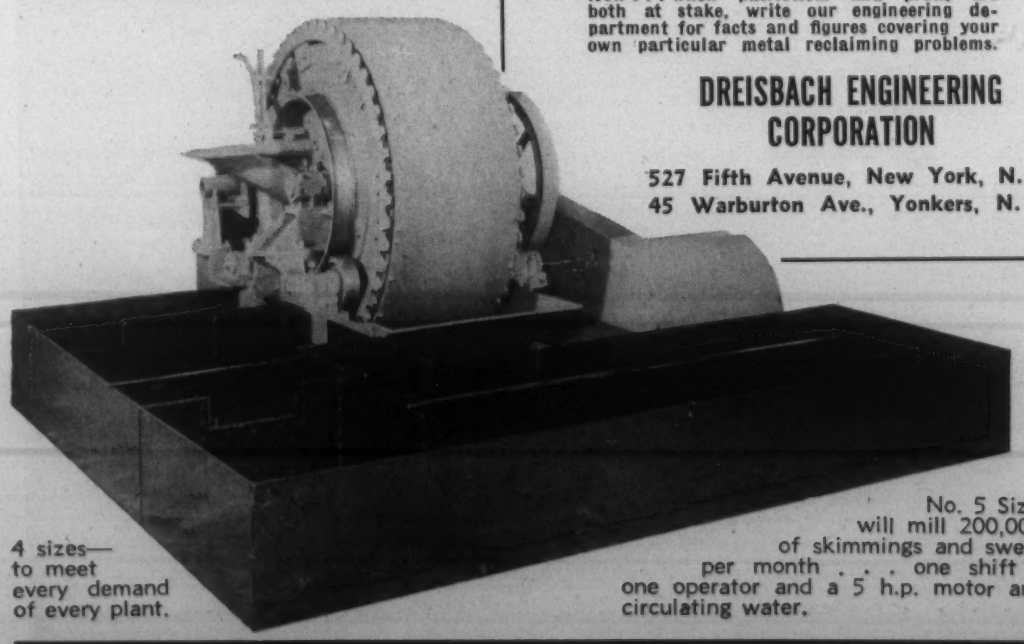


4 sizes— to meet every demand of every plant.

No. 5 Size Mill will mill 200,000 lbs. of skimmings and sweepings per month . . . one shift . . . one operator and a 5 h.p. motor and recirculating water.

change in characteristics, which are controlled by the amount of rebonding materials added. Excessive addition of any rebonding clay or organic material can be harmful.

Foundries having no intensive mixing equipment are to be cautioned against adding too much resin binder to their sand heaps. If too much resin binder is added, the sand may gradually become "water-proofed" to such a degree that it is not readily wet by water.

Resin binder is frequently used in conjunction with other organic materials, such as sea coal, cereal or pitch. Resin binders are being used today by steel and gray iron foundries producing castings in green, skin-dried and dry sand molds.

—Emile Pragoff, Jr. & C. P. Albur,
Am. Foundrymen's Assoc.,
Preprint No. 42-42, April 1942 meeting, 39 pp.

Arc Furnace Refining Slags

Condensed from "Metal Treatment"

Much has been written about basic open-hearth slags and a tremendous amount of research has been done on the subject. Most of this is applicable to the oxidizing slags and some of it to the refining slags used in the basic electric arc furnace.

Unfortunately, however, there is practically no published data of any scientific value on the neutral and reducing slags used during the finishing period in the arc furnace. The true functions and reactions of calcium fluoride and calcium carbide, for instance, are virtually unknown.

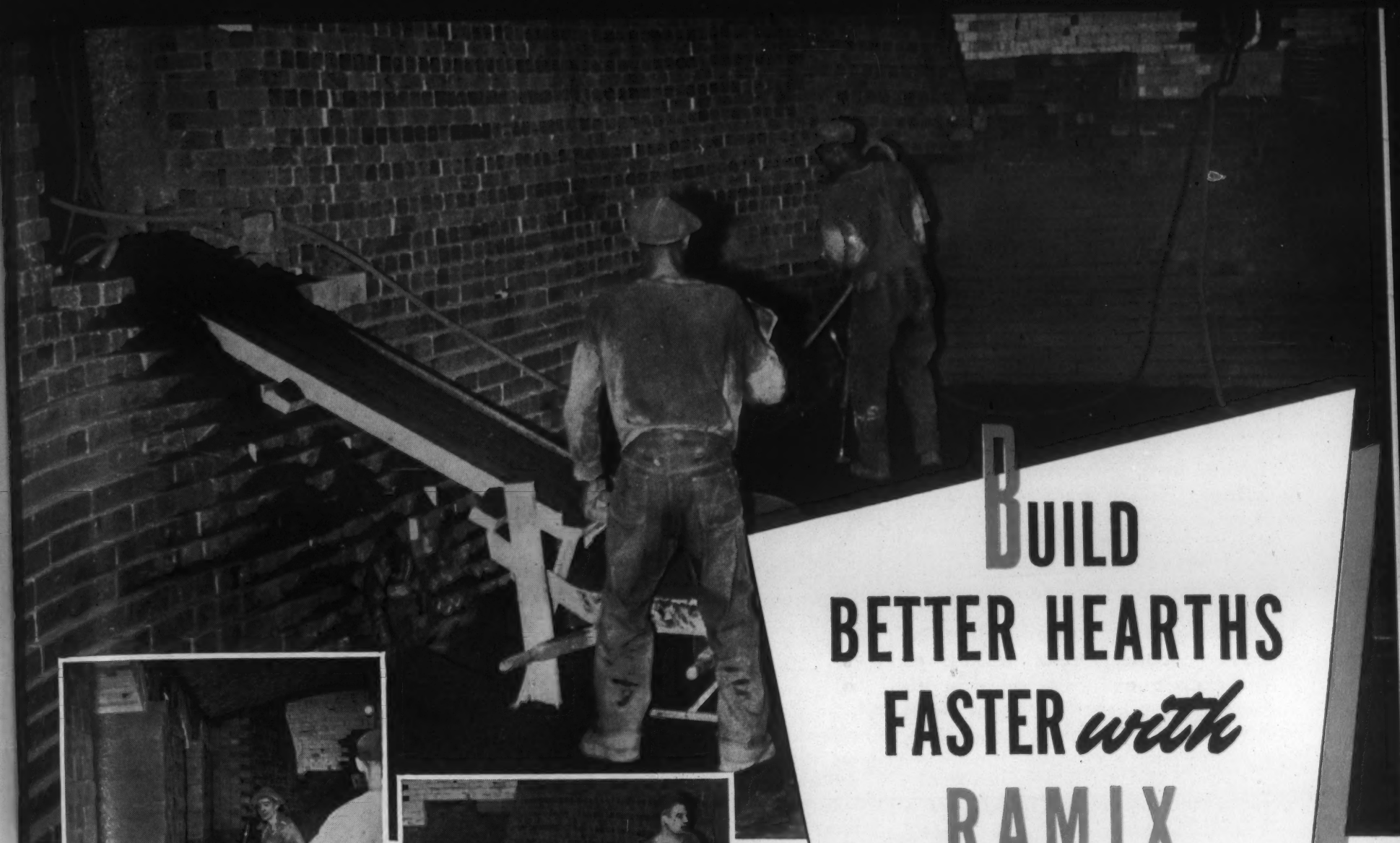
Using slag analyses from different plants in England and the U. S. A., an attempt is made to show the ill effects of using an unbalanced refining slag. The analyses were selected with particular care to eliminate as many undesirable variables as possible, excessive percentages of alumina or calcium carbide, for example.

Disregarding the ionic dissociation theory of liquid slags, the metasilicate, $CaO.SiO_2$, is the stable lime silica compound in slags at steelmaking temperatures. Any tricalcium silicate decomposes to lime and dicalcium silicate and the latter is nearly completely dissociated to lime and monocalcium silicate. From this it can be seen that the free lime available for desulphurization increases as the CaO/SiO_2 ratio rises above one.

Electric furnace refining slags are normally made up of lime, fluorspar and sand. Sometimes lime and fluorspar are used alone or, more rarely, a lime-silica sand mix. The advantages of using a lime-fluorspar-sand mix are apparent from the following argument.

Admittedly, fluorspar lowers the viscosity of the slag or enables it to carry a higher concentration of lime without increasing the viscosity. On the other hand, the use of lime and fluorspar alone gives a fiery, vicious slag which attacks the slag-line. This naturally results in an increase of magnesia in the slag, the CaO/SiO_2 ratio drops, lowering the desulphurizing powers of the slag.

If the slag-line attack is so severe that the banks are undermined, large pieces of dolomite fall into the slag. If these are not quickly spotted and raked out,



BUILD BETTER HEARTHS FASTER *with* RAMIX

Large photo, above: Ramming bottom in new furnace. Note opening left in backwall for chuting in Ramix.

Small photos, below: Ramming banks behind wooden forms, after completion of flat. To save time forms should run entire length of furnace.

● **Ramix is an open hearth time saver, first aid to war production. Cold-ram a new bottom with this refractory and you'll be making steel a week to ten days earlier than if you had burned in the usual magnesite-and-slag hearth.**

Not only time, but skilled labor, is saved. Because it is rammed in place by common labor, a Ramix hearth can be completed and put into production with minimum demand on the time of your experienced furnace operators.

Ramix is a scientifically bonded, high-magnesia refractory, manufactured under close laboratory control. The bonding elements used stabilize the magnesia against the hydration that so often occurs in grain magnesite hearths and in magnesite brick during periods of prolonged shutdown. The practical value of the built-in properties of Ramix is being proved daily in service in more than 150 hearths. Tempered with water and rammed in place, it consolidates into a hard monolith. It bonds well with brick and other bottom material. Under temperature, it develops into a dense, homogeneous structure that is not readily attacked by slag or metal, and requires a minimum of maintenance and repair through a long life.

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MAGNEFER—Dead-burned dolomite for hearth and slag line maintenance.

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RAMIX—An air-setting basic refractory for rammed hearths and cold furnace repairs.

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OHIO MAGNESITE—Domestic dead-burned high-magnesia grain refractory, equal to Austrian.

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RAW DOLOMITE—Washed open hearth dolomite in rice size and standard ⅝-inch.

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-says WPB

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In the past, some foundrymen have considered these alloys difficult casting jobs, due to oxidation and gas absorption during the melting operation.

To solve these production problems we offer ALBRAL — a FOSECO product with *tested* and *proven* ability to overcome the difficulties of casting tin-free alloys.

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they will go into solution in the slag, causing it to become hopelessly out of condition.

Although the lime-fluorspar mix may give a highly basic slag early in the refining period, the ensuing slag-line erosion rapidly lowers the CaO/SiO_2 ratio. Iron and manganese oxides are picked up, decreasing the desulphurizing powers of the slag still further. Another disadvantage is that the iron and manganese oxides in solution in the magnesia are particularly difficult to reduce.

The chance of direct desulphurization due to the formation of volatile compounds of sulphur and fluorine is remote. Practical observations indicate that carbon tetrafluoride, a gas stable at high temperatures, results from the interaction of calcium carbide and fluorspar. As this will cause wastage of both materials, it is advisable to use slags high in fluorspar when strongly carbide conditions are required.

On the other hand, if a lime-sand slag is used, adequate basicity is accompanied by loss of fluidity, the slag is unreactive and not much sulphur is removed. If the basicity is lowered to give sufficient fluidity, the slag becomes nearly chemically incapable of removing sulphur.

It is, therefore, better to compromise between the highly reactive lime-fluorspar slags and the less basic lime-sand slags by using a well-balanced lime-fluorspar-sand mix.

—N. F. Dufty, *Metal Treatment*, Vol. 8, Spring 1942, pp. 17-18.

Rolling Aluminum

Condensed from the "Journal of the Institute of Metals"

A study of the grain size of aluminum sheet and strip of commercial purity, gives some interesting data on the effects of hot rolling, cold rolling, annealing conditions and metal purity thereon.

A rapid rate of heating through the recrystallization range, a high temperature during rolling, heavy pinches during a cold rolling, and a high iron content are all factors that favor development of fine grain on annealing. Prolonged annealing, high annealing temperature, and high silicon contents should be avoided as favoring coarse grain.

Rolling to thin gage without intermediate annealing frequently results in the production of a comparatively coarse-grained structure. The imposition of an intermediate anneal at a point sufficiently remote from the finishing thickness is often beneficial.

Minor impurities, unless present in excessive amounts, seem to have little effect on grain size. Temperature and strain gradients do not seem to cause unusual grain growth in aluminum. The initial stages of recrystallization were studied, and theories advanced to account for the existence of the maximum in the grain-size cold-work curve, and for the variations which have been found between samples rolled under controlled and apparently identical conditions from duplicate rolling blocks taken from the same cast.

—H. W. L. Phillips, *J. Inst. Metals*, Vol. 68, 1942, pp. 47-106.

Mineral Supplies of the Axis

Condensed from an American Zinc Institute Paper

German and Japanese conquests up to the present time have mitigated to a considerable extent the serious deficiencies in mineral supply that confronted the Axis at the outset of its program of aggression, but the United Nations still maintain a substantial superiority in mineral resources, which together with their enormous industrial capacity can assure successful completion of the war. Winning the war is chiefly a problem of quickly converting potential mineral output into usable material, and of speedy organization and efficient use of man power and plant to employ these mineral materials in effective military effort before the enemy becomes intrenched in impregnable military positions.

The success of the Axis drive, in the light of the basic material resources of Germany, Japan, and Italy, is almost unbelievable. These countries that originally occupied only 3 percent of the land area of the world, accounted for only 10 percent of the population and controlled not more than 5 percent of the mineral resources of the earth, today dominate 13 percent of the land area, 35 percent of the population and about a third of the mineral wealth.

Military Aspects

Direction of Axis expansion has been influenced to a considerable extent by mineral objectives. Hitler's anticipated drive to the Southeast, and Japan's move to the Southwest, strike at rich and strategic mineral areas that heretofore have contributed much to the industrial strength of the United Nations.

The shutting off of supplies of tungsten and antimony from China, and of tin, manganese and chromite, as well as rubber, manila fiber and other non-mineral commodities from Southeastern Asia already constitutes a serious loss to the United Nations, and if the anticipated pincer movement on the Indian Ocean isolates the Asiatic Continent we face the loss of more important sources of manganese and chromite, strategic mica and flake graphite.

Russia's military power has been damaged by the loss of the manganese, iron and coal industries of the Ukraine. At the same time the most serious deficiency of the Axis, petroleum, has been alleviated in part by Japan's occupation of Malaya and the Netherland Indies. Germany has obtained valuable raw materials and facilities for manufacturing munitions in Europe, and seeks the rich petroleum prizes of the Near East.

The control over mineral resources gained by the Axis, however, cannot be considered as an equivalent gain in military power. For example, tungsten and antimony in the interior of China not yet occupied by Japanese troops is cut off from the United Nations, but it only partly available to the Axis. Restoration of production schedules and transportation in newly conquered territory is at best a difficult job, and doubtless many production facilities have been destroyed under the "scorched earth" programs of the invaded countries. Despite

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Tungsten, Molybdenum, Boron—Boron, Molybdenum, Tungsten—interest concentrates now on one alloying element, now on another, as of crucial importance for the war. Very marked attention is at present given to Boron, because of new knowledge that has recently been brought to light.

Minute additions of this relatively abundant element, to steels and irons, yield properties otherwise obtained only by use of scarcer imported materials. One specific advantage in many cases is deep penetration of hardening effects, accompanied by an increase of yield and ultimate strength.

Researches on Boron have been conducted for some time by the Molybdenum Corporation of America and more recently verified under a fellowship at a leading university. A patent for the effective incorporation of Boron in irons and steels has been secured and its results will be made available to any American manufacturer. Inquiries are welcomed.

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these difficulties the improved mineral position of the Axis countries has strengthened their capacity for war.

Some Axis Gains

Before the Austrian anschluss, Germany, Italy and Japan accounted for only 6 percent of the iron ore production of the world. Today they dominate 46 percent and if they are successful in the drive on the Indian Ocean they will control or isolate 55 percent of the world's output. Axis capacity for steel production, today one of the foremost implements of war, has increased from 20 percent to 34 percent of the world total.

Considerable progress has been made by the Axis powers in relieving serious nonferrous metal shortages; their control of copper mine production has increased from 5 percent to 10 percent; lead from 7 percent to 22 percent, and zinc from 16 percent to 27 percent. As a result of Japan's occupation of British Malaya and the Netherlands Indies, the Axis now dominates territory that produced 72 percent of the world's tin in 1940, whereas only a few years ago Germany, Japan and Italy accounted for only 1 percent.

Notable acquisitions of copper and zinc refining capacity also have been made, chiefly in Europe. Today the dictators control 17 percent of the world's copper refining capacity, and 44 percent of the zinc smelting capacity, whereas, in 1937 the percentages were 11 and 10 respectively.

The Axis powers, particularly Germany, have occupied a prominent position in the production of light-metals in recent years. Germany took the lead in 1938, but the United States regained it in 1941. In 1937 the Axis accounted for 33 percent of the total production. Areas now under its control produced 54 percent of the world's aluminum in 1940 and 49 percent of the world's bauxite. The Axis was producing 2/3 of the world's magnesium in 1940.

The United Nations probably already have overtaken the Axis in aluminum production, and upon completion of present plans for expansion they will have a large lead in this commodity. Our production of magnesium likewise should soon surpass that of the Axis.

Before the War the Axis nations were exceedingly short of the ferro-alloying minerals, the minerals that make armament tough and bullets hard. This situation was met in part by pre-war stockpiling, but chiefly by aggression. Axis control of manganese production has increased from 2 percent to 30 percent; chromium from 3 percent to 30 percent, and tungsten from 6 percent to 60 percent. If the move toward the Indian Ocean is successful the Axis will control or isolate more than 2/3 of the world's supply of these highly strategic raw materials.

—E. W. Pehrson, *American Zinc Institute*, April, 1942

Saving Sink-head Steel

Condensed from "Stal"
(abstracted in "The Engineer's Digest")

In the open hearth shop of the Kriov (Russia) Works, the possibility of reducing the amount of metal cut away in headers when casting killed-steel ingots was investigated. Big-end-up molds were used, and the teeming was done from above, through an intermediate runner.

Two types of hot tops were employed —a narrow and a wide. With equal filling levels the metal content of the wide type was greater than that of the narrow by about 4 per cent of the total weight of the ingot.

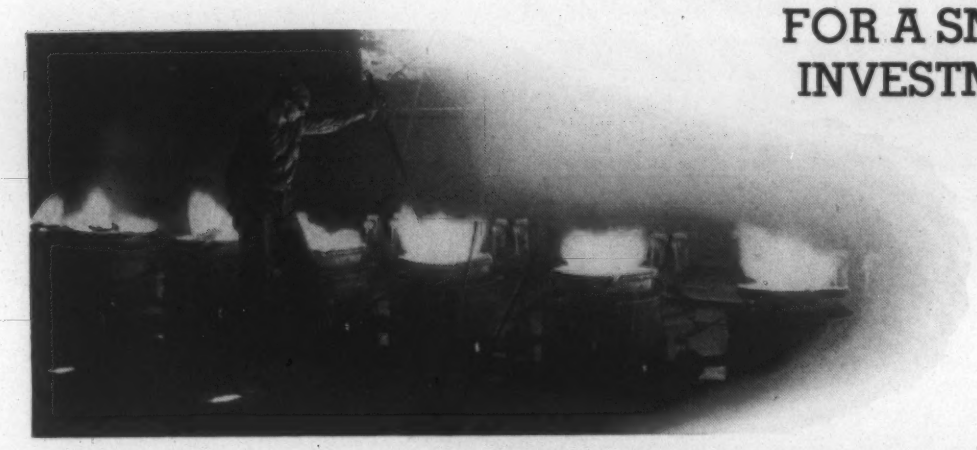
With either type of sink-head there was pronounced irregular segregation in the upper part of the ingot and a secondary concentric spongy region. The latter is likely to re-appear in the cross-section of the rolled blooms and is an occasional cause of their rejection.

The weight of unsound metal which must be removed is smaller for the narrow type of sink-head because the shrinkage hole is more sharply localized. The narrow type was, therefore, definitely adopted for production and this change, incidentally, was found to result in an appreciable reduction in the number of ingots suffering from transversal cracks.

It was found that with the use of "Lunkerit" (a powder composed of 18 per cent metallic aluminum, 15 per cent of 45 per cent ferro-silicon, 12 per cent bauxite, 25 per cent charcoal and 30 per

FOR MELTING NON-FERROUS ALLOYS

BIG PRODUCTION FOR A SMALL INVESTMENT



INSTALL CRUCIBLE FURNACES

Shown in the illustration are 8 No. 70 Crucible Furnaces using oil fuel. (Gas can be used just as well.) The crucibles are lifted out with tongs and without transferring the metal to any other container the flasks are poured off *direct*. The metal can't chill. Meanwhile another crucible is set in the empty furnace and in thirty to forty-five minutes another crucible full of clean, non-gassed metal is ready to pour. THAT'S SPEED.

And think of the FLEXIBILITY: The alloy may be changed whenever desired. There is no absorbed metal in the crucible to contaminate the next melt.

MELTING COST with crucible furnaces, either stationary or tilting types is well recognized to be the lowest by far: the investment charge is the smallest item in the total cost when you install CRUCIBLE FURNACES.

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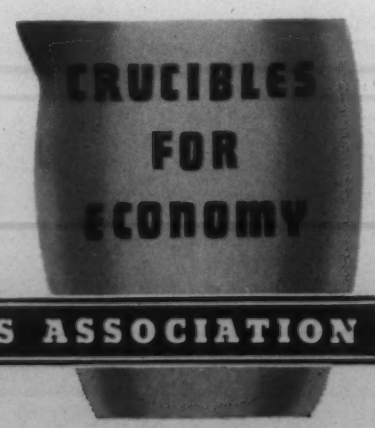
Don't decide on non-ferrous melting equipment without consulting a CRUCIBLE FURNACE MANUFACTURER or write to the address below for information.



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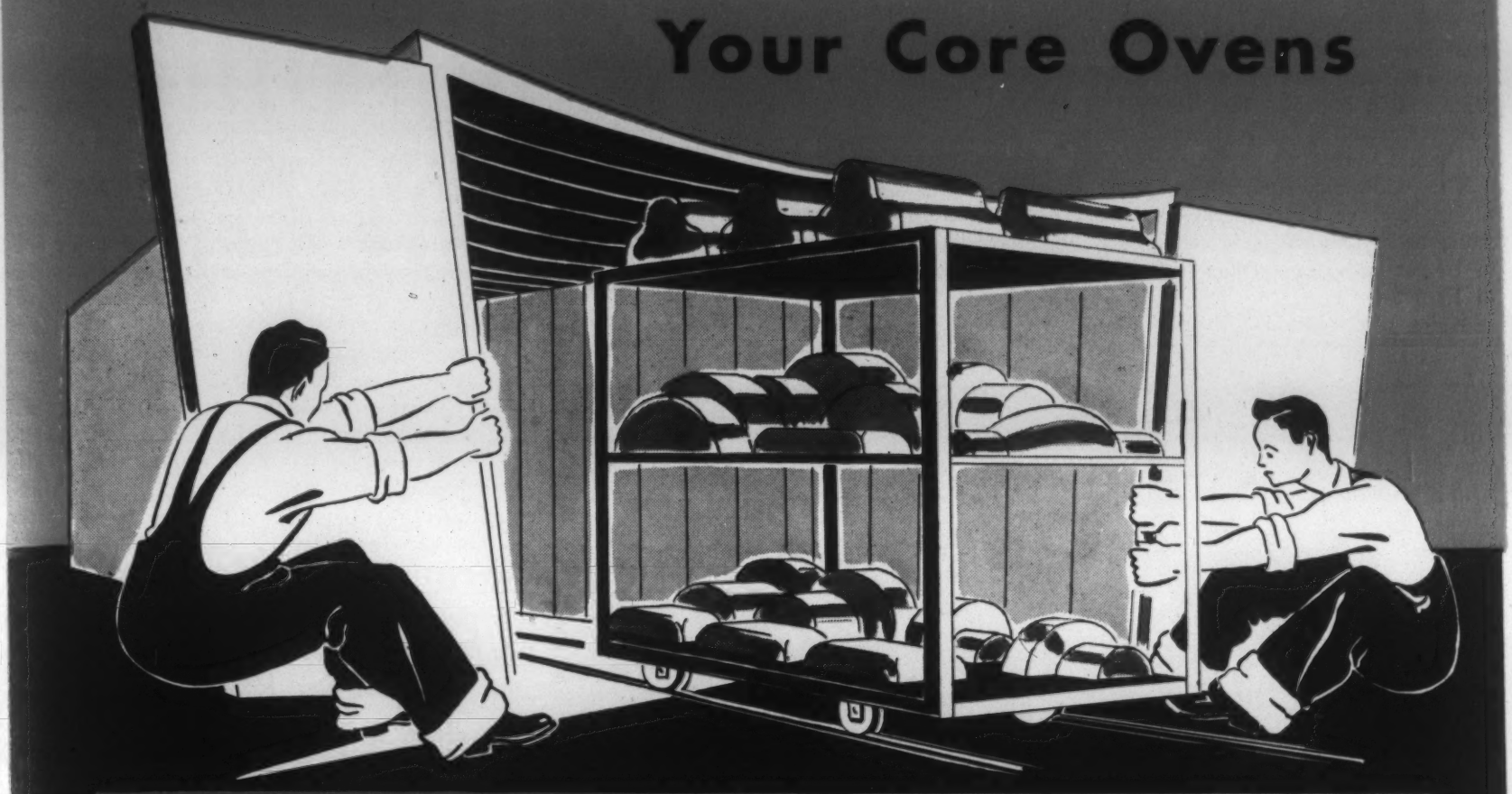
How to S-T-R-E-T-C-H Your Core Ovens



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If you want to s-t-r-e-t-c-h your core ovens—get more cores through per shift—without extra cost—consider the experience of many foundries—now using Truline Binder—who find their core output substantially increased, sometimes even *doubled.*

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Where conditions are right*, Truline can do an excellent job for you. At least, that's the experience of an ever-growing number of foundries now using it. Why not ask for the impartial advice of our Truline service man in your district?

* **TRULINE BINDER** is useful in cores for steel, grey and malleable iron, brass, bronze, aluminum and magnesium castings. Wherever bank sands, reclaimed sands, or natural-bonded sands are a part of the picture—wherever high collapsibility is wanted—or where thin metal sections must be protected—Truline Binder is indicated as a real time-saver.

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cent burnt fire-clay, sprinkled on the surface of the metal immediately after pouring at the rate of 2 lbs. per ton of metal) and by filling the narrow type of sink-head mold to a level of only 15.5 in. it would be practicable to reduce the weight of waste metal to only 15 per cent of the total ingot weight, and to keep the defective metal entirely in the header. Any reduction in pouring level below 15.5 in., however, resulted in an increase of waste to about 17 per cent.

The wide type of hot-top required a filling level of 14 in. and the amount of metal to be removed generally worked out to 16 per cent but occasionally went down to 13 per cent.

With the same filling levels and no Lunkerit, there was 3-4 per cent greater wastage of metal.

—G. G. Ostapenko, Condensed from *Stal*, abstracted in *Engineers' Digest*, Vol. 3, Feb. 1942, pp. 62-64.

Plaster Molds for Aluminum Castings

Condensed from "The Iron Age"

The use of plaster mixtures for molding aluminum as developed by the Antioch Foundry, is well adapted for casting large highly stressed parts to close tolerances. This process is especially adaptable when complicated coring problems exist, where compound curves are required and where reduction of weight in stressed parts is important.

An ideal molding medium must have easily controlled shrinkage or expansion characteristics, high permeability, fine surface structure, high green strength, but low strength after pouring and controllable thermal conductivity factor. The plaster-mold process described has a high initial cost but low final cost.

Patterns follow the general design of sand patterns whenever possible. In cases of complicated patterns which can be made economically only by using a wood model, U. S. Gypsum's "hydrocal" is used to advantage. Protective coatings must be used on wood patterns to withstand the moisture of the plaster mix.

Draft allowances are about 0.004 in. for first inch, per side. After the first inch, draft of 0.002 in. is possible. Wall thicknesses of 1/8 in. can be kept within 1/64 in.; 3/32 in. wall areas can be cast in sections 8 x 10 in., while 1/16 in. walls have been cast in areas 4 in. square.

The accelerator addition may be set plaster, epsom salts, etc. Patterns are surmounted with the flask and the liquid mixture poured in. The molds are kept in autoclaves for 9 hrs. Steam at 15 lbs. pressure and 260° F. is used. Excess water is removed by drying in air circulated at 350° F. for from 8 to 48 hrs. The finished molds have a permeability of 40 A.F.A. and tensile strength of 20 lbs./in.^{2}

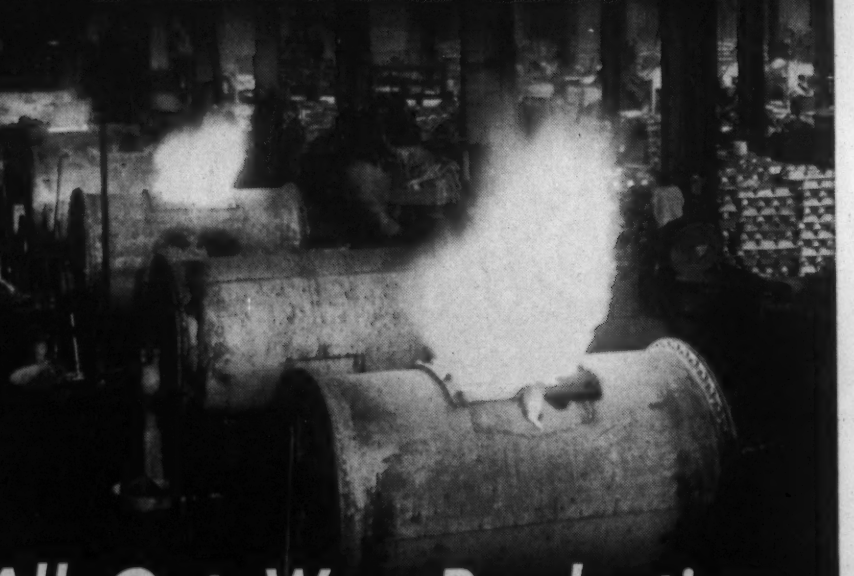
The desired characteristics of plaster mold are achieved by a treatment where a "recrystallization" process occurs within the plaster mixture. In this treatment, the calcium sulphate dihydrate of the mold is uniformly converted to the hemihydrate; then the mold is automatically saturated with moisture to reconvert to dihydrate, and to provide excess water at the interfaces at which recrystallization can occur.

The conditions favorable to recrystallization are maintained until the desired redistribution in larger grains has occurred. Finally, the mold is dried. The most practical way of obtaining dehydration is to subject the mold to an atmosphere of slightly superheated steam in an autoclave. In the autoclave treatment about ¾ of the water of crystallization is liberated.

—R. R. Kay, *Iron Age*, Vol. 149, Apr. 4, 1942, pp. 50-54.

HAUSFELD

ALUMINUM MELTING FURNACES



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Because of one of those mistakes which seem to occur occasionally despite all precautions, several hundred of our subscribers received a notice the last week in May that their subscriptions were about to expire, although actually they had several months yet to run.

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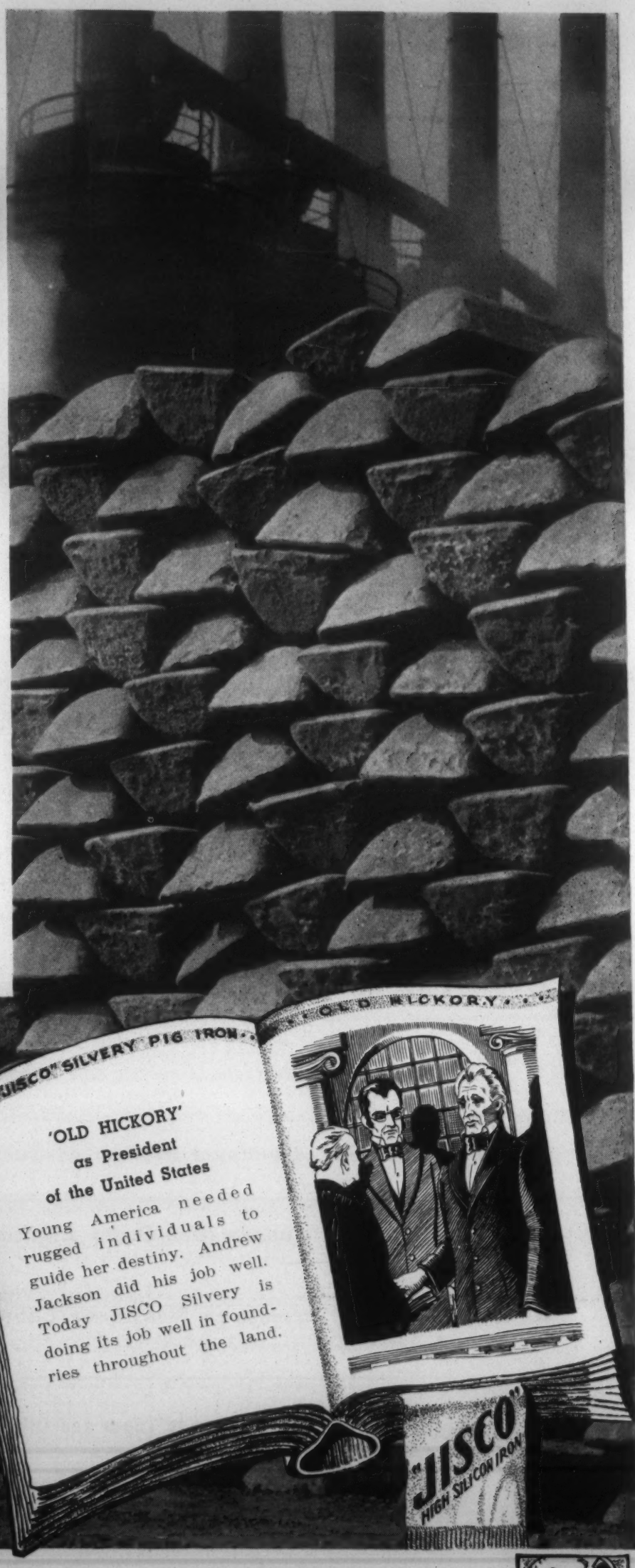

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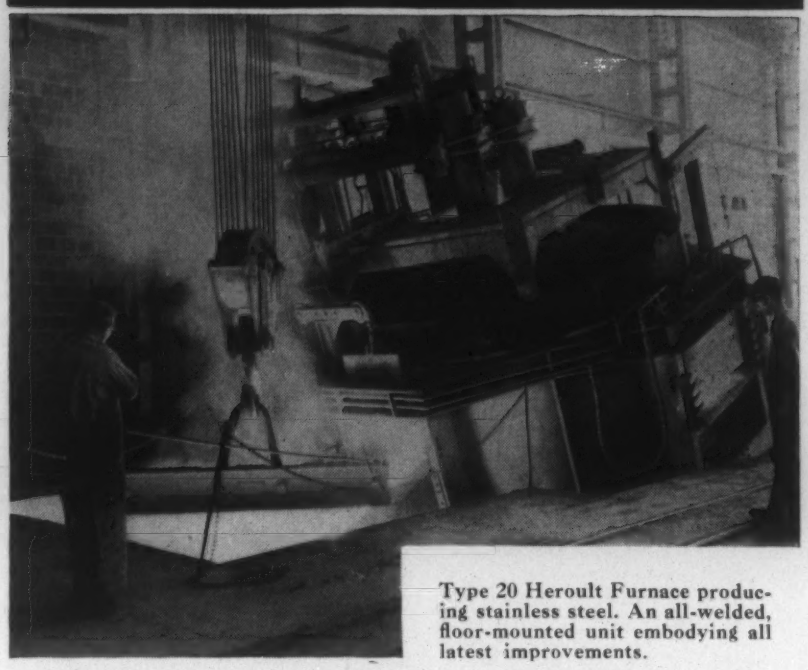

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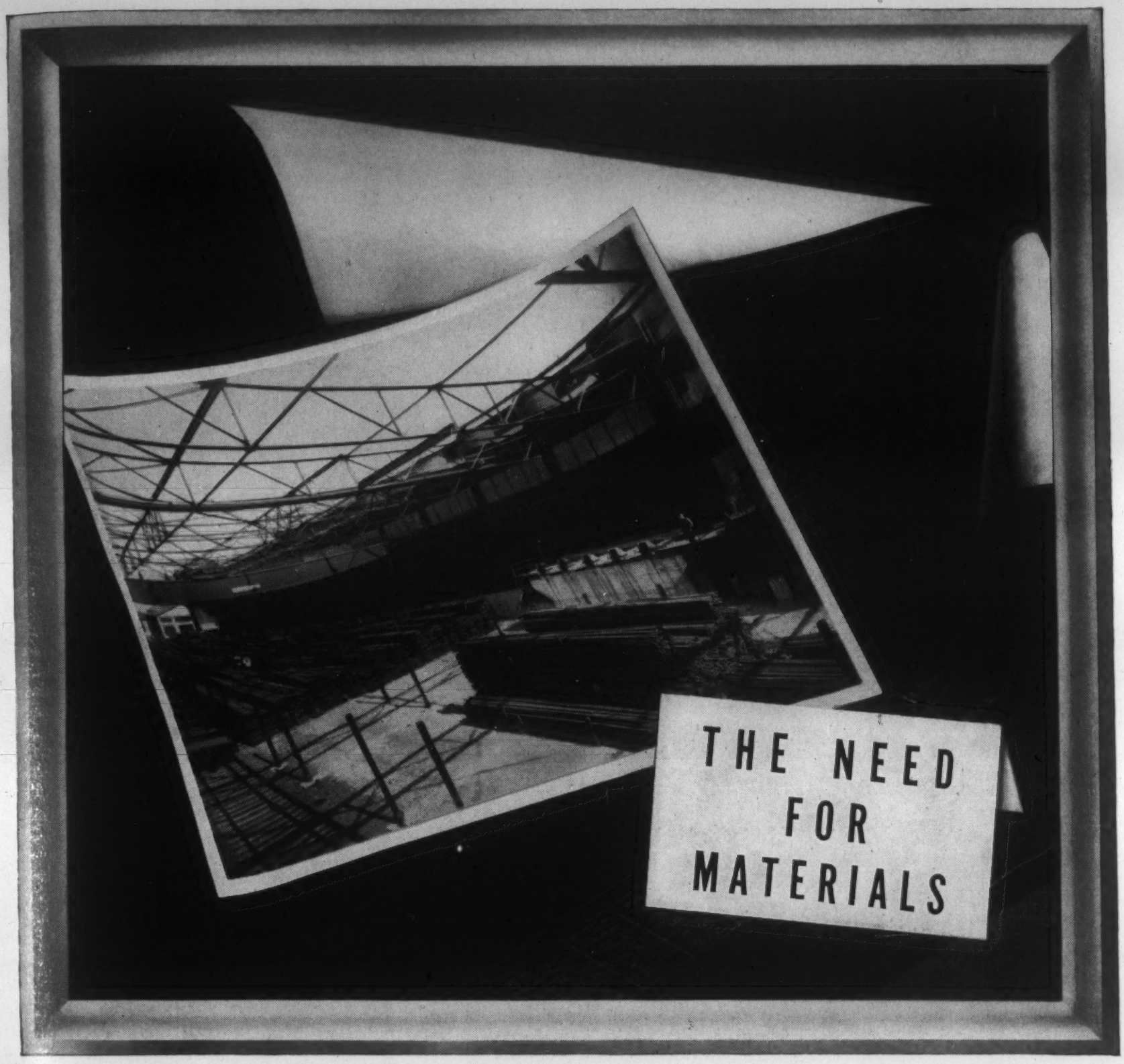
—THE PRODUCTION FRONT—

A New Department By Harold A. Knight, on page 907.



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Finishing Welded Light Metals

Condensed from "Sheet Metal Industries"

In welding light alloy components, welds at corners, lapped surfaces, and inaccessible places should be avoided. If a joint is made between a light sheet and a heavier section, the thicker section should be bevelled gradually to the same thickness as the thinner section.

Flanged edge joints are very undesirable as flux inclusions are almost invariably obtained. Furthermore, the unfused lower edges constitute a severe notch, which weakens the joint in static and alternating tension.

Different alloys require different fluxes. Fluxes for aluminum do more than simply dissolve the surface oxide film; the flux reaches the underlying metal by means of cracks and discontinuities in the oxide coating or by means of the action of the small amounts of fluoride generally present in the flux on the coating; then the chloride which constitutes the major portion of the flux attacks the aluminum to form aluminum chloride, which is readily volatile and lifts pieces of oxide which are floated off in the molten salt.

Therefore, any small residue left on the metal will severely attack. Furthermore, these residues are hygroscopic (a finished joint made with a well known flux gained 155% in weight after 20 hrs. exposure in an atmosphere of 60-70% relative humidity at 68° F.) thereby increasing the corrosive effect. Fluxes for magnesium-rich alloys act chiefly by dissolving the film of magnesium oxide on the surface, but the products formed are just as hygroscopic and corrosive as in the case of aluminum.

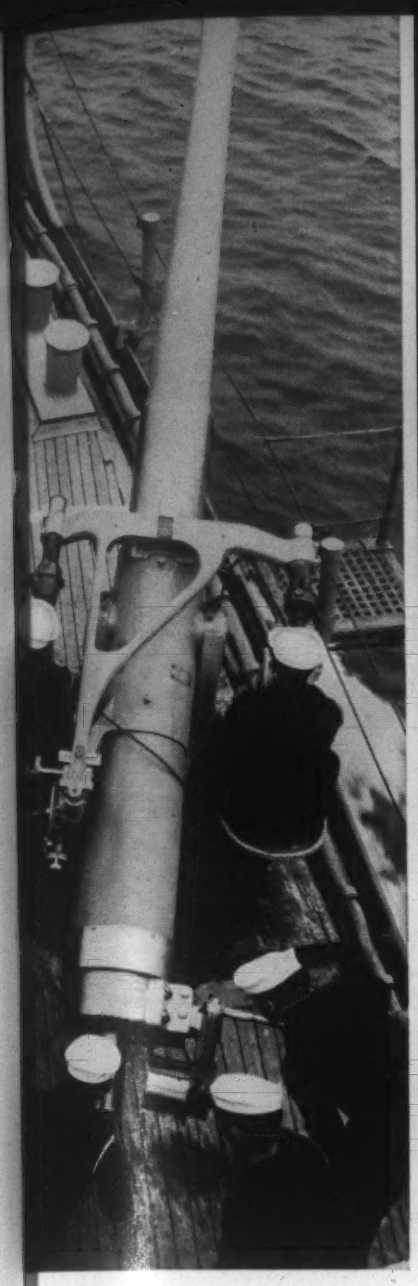
The only effective way of ensuring complete flux removal is the plentiful use of hot water; chemical treatment and high pressure steam are not adequate. The following procedure is recommended: (1) immediately after welding, the work is placed in a tank of water for at least 20 min. The temperature should be between 200° F. and boiling. Counter-flow principle can be used advantageously. The water should be reasonably free from chlorides (if heavily chlorinated water is used, it should be boiled to eliminate the chlorides), as indicated by a silver nitrate test.

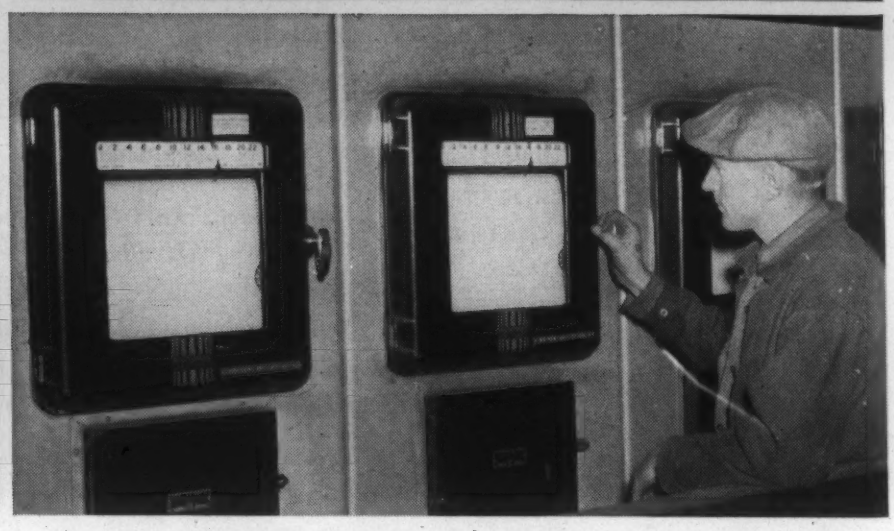
(2) Scrub well with bristle brushes, remembering that splashes of flux may be present anywhere. (3) Wash again in hot running water for a few minutes. (4) Acid dip if necessary in 5-10% nitric acid, hot or cold. Care should be taken that the metal is not attacked. (5) Rapid rinse in cold water.

(6) Wash again in hot water if an acid dip is used. (7) Drain and dry; an air current warmed to 140°-175° F. is generally best (direct along the surface rather than at right angles), but small articles may be dried in hot sawdust. Aluminum alloys with magnesium are especially difficult to wash.

(8) A chemical treatment such as chromating of magnesium alloys and anodizing or chemical oxidation of aluminum-rich articles may replace this final drying step.

—"Agricola," *Sheet Metal Inds.*, Vol. 16, Mar. 1942, pp. 361-362, 368





Official U. S. Navy Photo

The handling of Industry's big furnaces, like the handling of big guns, is a job for trained men with fine instruments. Here are Micromax pyrometers, regulating the temperature of an Ohio steel mill's cover furnaces.

MICROMAX TURNS ON THE HEAT FOR MORE WAR-TIME STEEL

Annealing steel strip for use in guns, ships, tanks, etc., is the job of the battery of Micromax-controlled cover furnaces shown above. The furnaces are Wilson radiant-tube units, having a capacity of several tons each. Temperature is controlled by Micromax Thermocouple Pyrometers directing the action of fuel-valve drives. The instruments themselves are standard, but the details of their installation present some features of value for other instrument users.

The Pyrometers are in a Control Room, back against the building wall. They are out of the way of cranes, trucks and unauthorized fingers, and are also well away from the cover furnaces, which, of course, are moved about in the big annealing shop.

Furnaces have some couples embedded in the load; others near the tubes. Valve-drives are permanently mounted on the furnaces; one can be seen in the foreground.

The method for connecting furnaces to Micromax Controllers is to have long lead-wires from both couples and valve-drives, and from the instruments. By means of standard terminals, a furnace any place in the shop can then be "plugged in" to a Micromax Controller.

The controller may turn fuel up and down rather abruptly (on-and-off control) or it may throttle it gently (proportional-position-plus-floating control). The method used depends on the type of furnace, the load, the job to be done, and so on. It may go from one method of control to the other, and base its work on a thermocouple in the load, or on one outside. It may regulate rate of heating and cooling as well as soak temperature.

But, whatever its instructions, Micromax carries them out in *its own fully-automatic way*. Naturally, in a big steel mill, the operators don't just walk away and leave an acre of furnaces entirely to the automatic controls, but, as far as Micromax (Model S shown) is concerned, even this could be done for some days at a time.

For Micromax needs no daily attention. It standardizes itself, thus preserving its own accuracy. In 24-hour service, it needs ink every 2 weeks or so; chart perhaps once a month; oiling, cleaning and dry cells only at long intervals. Even if an operator wants to "baby" the pyrometer, there's very little he can do. The machine attends, micro-responsively, to its job of regulating temperature; records the results as it goes along; helps turn out steel which is perfectly annealed for America's growing war machine.

Micromax Controllers are available in 5 models, and most applications are, of course, far simpler than the one described above. Our engineers will be glad to help you select and apply the one to regulate any furnace in which you may interested.

A G-E Catenary-type electric furnace, for normalizing steel strip, is controlled by this battery of Micromax Pyrometers in an Ohio steel mill. Heating chamber is 31 ft; cooling is 60 ft; power rating is 460 kw, 220 volts, 3 phase. A typical example of how Micromax is selected for the vital, big jobs of temperature control throughout the metal industries.

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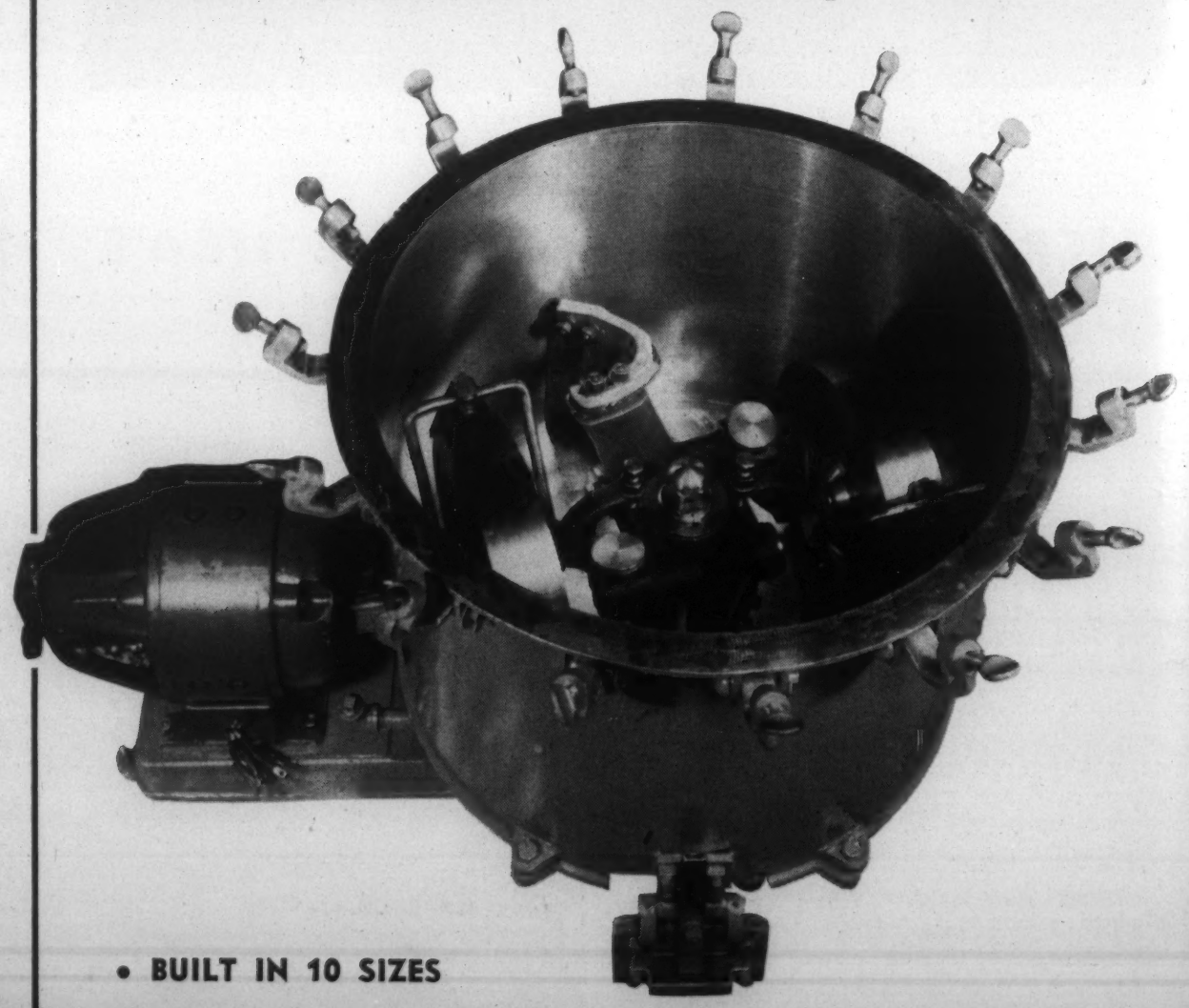

• *Above are a few typical powder metallurgy parts made from materials mixed and blended in a Simpson Intensive Mixer. These modern machines are built in a wide range of sizes, available with electric heating elements or steam jacketed, to meet any production requirement. At the right is a Laboratory size machine with stainless steel pan to guard against contamination and electric heating elements for temperature control.*

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Powder Metallurgy

A Composite

Much of the current deluge of periodical articles on both general and specific aspects of powder metallurgy is a reflection of the wave of attention given to it in the last year by engineers looking for faster-production methods or for ways to eliminate machining in part-manufacture.[1] Powder metallurgy is becoming constantly more firmly entrenched as a metallurgical engineering unit operation, and its products are ever more reliable.

There have recently appeared a number of very good general reviews of powder metallurgy, covering broadly the manufacture of powders; their mixing, pressing and sintering; the fields of applications of the process; and its general advantages and disadvantages. Those by Jones,[2], Kelley[3], Kalischer[4] and Hardy[5] are recommended for (among other things) the background information they contain.

Some Process-Application Trends

Many of the most interesting recent developments in powder metallurgy have been in the direction of new applications of the process—such as the copper-nickel-lead automotive bearing[6], the oil pump gear[6], the Alnico magnet[6], and the glass sealing alloy[7] described at M.I.T. Powder Metallurgy Conferences, the porous-metal filter[8], sintered friction devices[9] and aluminum parts.

Outstanding among several recent general trends outlined by Kelley[3] are developments in the use of *iron* powder. The automotive industry has used oil-impregnated bronze bearings for years, but some companies are now producing bearings from sintered iron compositions. Iron parts to which carbon or graphite have been added may be sintered at a sufficiently high temperature to bring about diffusion of the carbon or graphite into the iron, thus forming a steel.

Hot-pressed iron brake drums, Kelley reports, have been made at Chevrolet Wheel and Axle, where steel scrap was made so fine by grinding that it could be cold-pressed, sintered and then reheated and hot-pressed into a die. Such drums tested in service were found to be as good as or better than those formed conventionally.

Geschelin[10] also notes a trend toward the substitution of iron powder, or a combination of iron powder and copper powder, for porous bearings. Amplex Div., for example, is producing bearings made with such powders that are satisfactory for unit pressures of 60,000-150,000 lbs. per sq. in. at zero velocity.

The size of the largest powder metallurgy parts is gradually increasing, too. Amplex is reported by Geschelin to have furnished bearings ranging from 12 in. to 18 in. O.D. The development of powder metallurgy parts approaching "normal" density by Amplex [also by Seelig[7] of Powder Metallurgy Inc. and, we are told, by Chas. Hardy] has also opened up new applications.

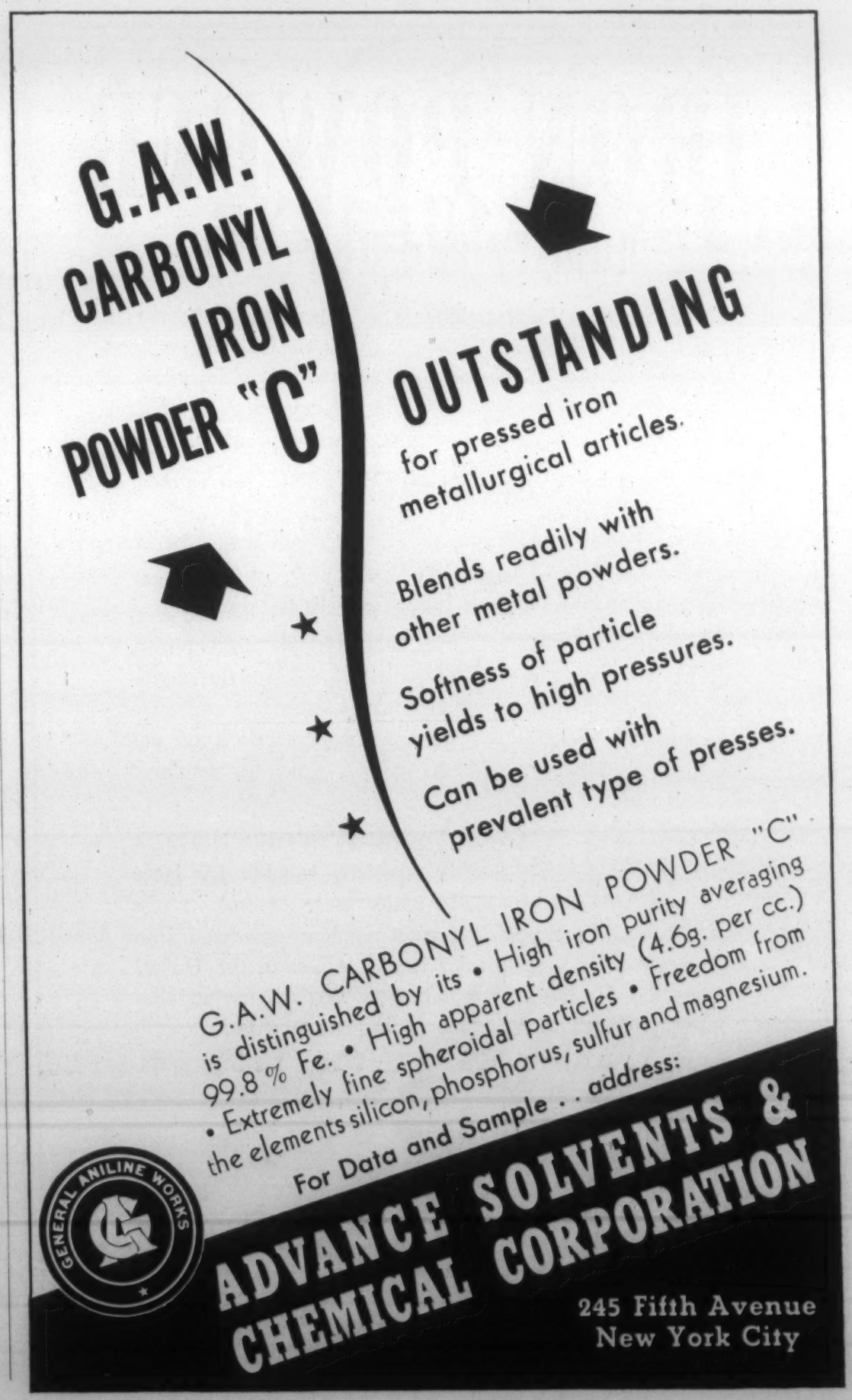
The more units required for a given job, the more "attractive" it becomes for powder metallurgy fabrication [although this does not mean that small-lot parts cannot advantageously be made by this process.] This is particularly important under today's war-production conditions, for powder metallurgy *can,* in certain circumstances, turn out small parts at an astonishing rate.

Hardy,[5] for example, reports that "one very essential part has just been offered at a production rate of not less than 500,000 pieces per day with a step-up to 1,000,000 pieces per day within a few weeks. Another part, which at the present moment requires tedious machining processes with from 60-70 per cent scrap, can now be produced at the rate of 20,000 pieces per day with no scrap."

As a guide to what can be done, some of the parts currently produced by Moraine Products Div. of General Motors and Amplex Div. of Chrysler, according to Geschelin, include thrust washers, fan bearings, oil pump gears, levers, cross heads, cams, automotive splined jack nuts, Gyrator gear sets, bearing retainers, indexing discs for dividing heads and various aircraft parts such as instrument components, engine-mount parts, carburetor shafts, pulleys, bomber turret parts, propeller parts, etc.

Limitations and Possibilities

Kelley[3] succinctly discusses the limitations and possibilities of powder metallurgy. Availability and cost of iron powder are naturally important factors. Even though Swedish sponge iron is no longer available, a few American companies are supplying iron powder of different grades. "If the



demand for this material is great enough, there seems now to be no question about being able to obtain it at a reasonable price."

Powders when pressed do not flow around corners. Hence, plungers must operate in straight lines, and withdrawal of the plunger and ejection of the compact after forming must be possible without breaking the part.

There are many automatic machines of the pill-machine type being used today to turn out small parts, but as the size of the part increases the machine tool cost rises sharply; labor cost goes up, too, since the largest presses are hand-operated.

Increase in size brings another difficulty —non-uniform distribution of pressure throughout the compact, with consequent non-uniform density if the sintering temperature is low or non-uniform shrinkage if the sintering temperature is high.

Many of the parts made of present materials, Kelley reminds us, are lacking in the strength, both tensile and impact, required for many applications. On the other hand, *some* materials (Geschelin mentions a pressed iron part with a tensile strength of 123,000 lbs. per sq. in.) compare favorably in physical properties with those normally employed for the specific service involved.

The advantages of the process are clear-cut. Millions of small parts, amounting to tons of material, can be turned out on automatic presses at low cost. Hardy[5] has seen parts—admittedly small—that were produced at the rate of 4,000 per min.! Machining time, equipment and scrap are obviated when powder metallurgy can be used. Intricate shapes may be formed with a single stroke of the press, and the size maintained by closely controlled sintering or by a cold coining ("repressing" or "sizing") operation after sintering.

Engineers familiar with design practice for forgings, castings, die castings, stampings and screw-machine products need similar information about powder pressings if the process is to be fully and intelligently utilized. D. Basch[11] has set forth the design factors for powder metallurgy as part of a series of articles that permit, in many cases, a direct comparison with other methods.

IRON POWDER

Quality and Quantity

The old Southern General who made the classic statement that the side usually wins that "gets thar fustest with the mostest," if alive today in this War of Machines would undoubtedly add —*"and the bestest equipment"*—for modern warfare demands inexhaustible quantities of the finest quality products.

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Iron Parts—General Fabrication

Some interesting glimpses of the fabrication of iron-powder parts, especially in General Motors shops, are given by Chase,[12] by Macconochie,[13] and in a pictorial article in *The Iron Age*.[14]

Chase describes the Tormyn process developed at Chevrolet Gear and Axle for making a special form of bearing sleeve. Until recently, this ring was a gray iron casting that required considerable machine work, but it is now sintered and pressed from "shredded" chips of S.A.E. X-1112 steel coming from the screw machine department. The sintered steel parts are stronger than the former gray iron rings, can be produced at a faster rate, and save machining and other costs.

An interesting variation of this practice in the use of scrap-steel powder for making sintered iron bearings at Moraine Products Div. is described by Macconochie[13], and some additional information thereon is given in an excellent pictorial article about Moraine's practice in general in *The Iron Age*.[14] The low-carbon steel scrap is ball-milled and then decarburized in a controlled-atmosphere furnace to give a soft, relatively pure iron powder.

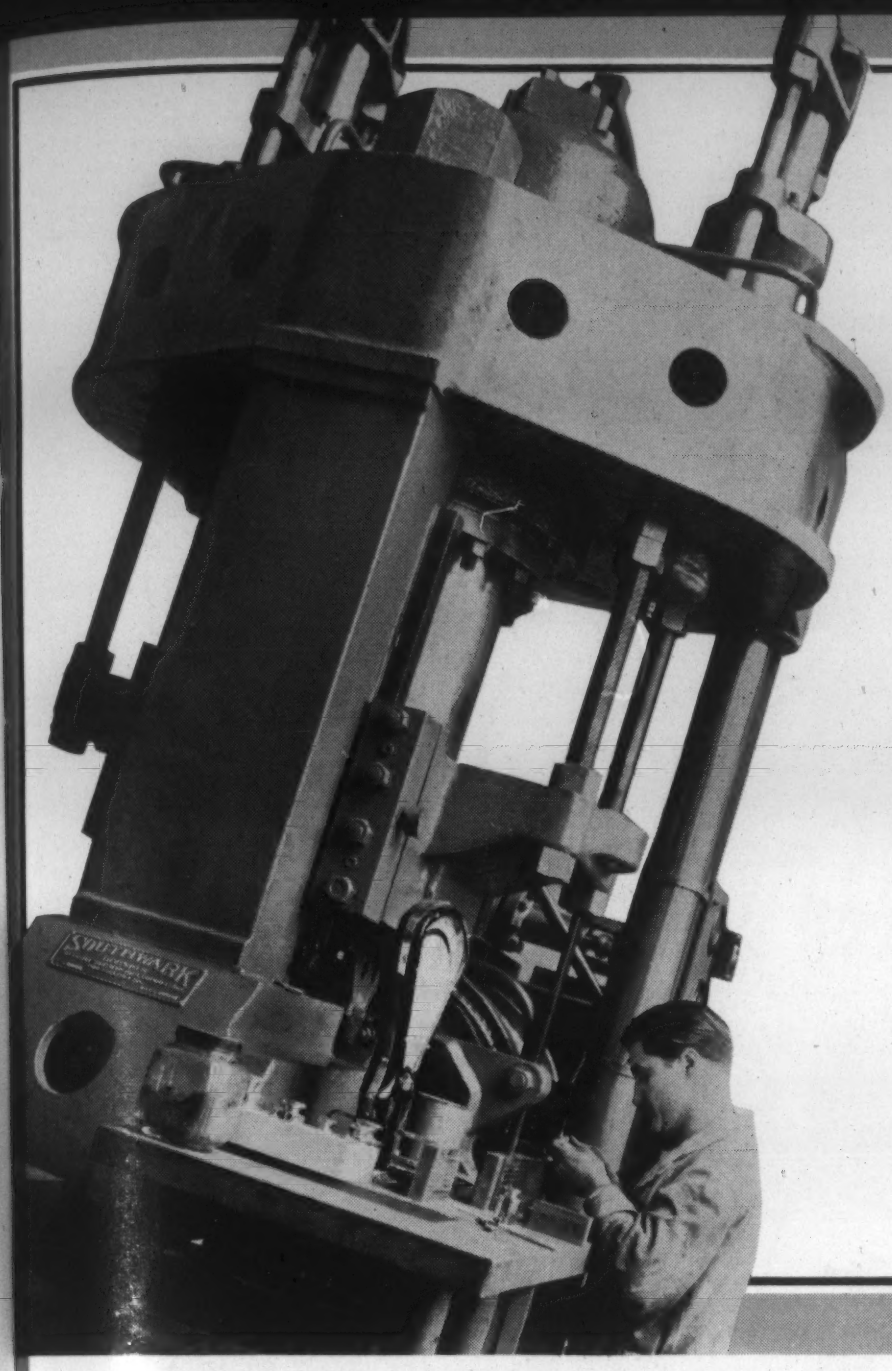
The iron powder is then passed through a 150-mesh screen, with 50 per cent going through a 325-mesh screen. Ultra-fine graphite powder to the extent of about 2 per cent is added to and mixed with the iron powder. The graphite serves to supply carbon for strengthening the matrix and also to aid in lubricating the dies during briquetting and the bearing itself during service.

Sintering Iron Powder

Kelley's work[3] on sintered iron and other "pure" metals at temperatures close to their melting points showed that sound bars may be obtained from pressed and sintered compacts when sintered for long enough times. For each metal, too, there is an optimum pressure—not necessarily the highest—where the highest densities are obtained. Sintering temperature and time are the most important factors and pressing pressure the least important in obtaining sound materials from powders.

Somewhat different results are reported by Libsch, Volterra & Wulff[15] in an article on iron powder and its sintering. These authors found that with electrolytic iron there was little improvement in strength after 4 hrs. time at sintering temperature (1550 deg. F.) except a slight increase in elongation. They also studied the effect of pressing pressure, but their

(Continued on page 1028)



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results cannot be checked against Kelley's since they studied as-pressed compacts whereas he investigated the properties after sintering.

Tests on compacts made from several types of iron, all pressed under usual [and presumably identical] conditions were sintered at various temperatures. Electrolytic iron reached maximum density and tensile strength at 1550 deg. F.; all properties dropped to a minimum when sintered at 1700 deg. F., but more than recovered at 2200 deg. F.

Other iron powders (reduced magnetite, reduced mill scale, and decarburized cast iron) did not develop as high tensile strengths as the electrolytic, although the drop at 1700 deg. F. was proportionately less severe for them. Their strengths after sintering at 2200 deg. F. were comparable to that of the electrolytic product after sintering at 1500 deg. F. On the other hand, grain growth is excessive between 1515 and 1650 deg. F. in electrolytic powder.

Pressing

A method of producing iron parts of high density and much improved physical properties is *hot-pressing*, discussed by Schwarzkopf & Goetzel[16] and by Goetzel[7].

Some of the practical fundamentals that govern the commercial pressing of porous bearings are reviewed by Langhammer & Smith.[17] Certain calculations are always involved in the design of briquetting tools. The amount of stock ω be left on the outside and inside diameter of the piece for sizing and also its length must be determined, as must the dimensional changes of the bearing during heat treatment.

Thus, to achieve a desired outside diameter in one hypothetical case of a 1.000 in. O.D. bearing, 0.010 in. must be added for sizing stock and 0.010 in. for shrinkage during sintering, so that the inside diameter of the briquetting die would be 1.020 in. The length of the briquetting die depends on the finished length of the piece and the density of the powder.

Choice of steel for the die parts may be made on the basis of cost per bearing, provided a production of more than 500 pieces is required.

High speed steel, because of its wearing qualities, is selected for the sizing die and punch. Oil-hardening tool steel may well be used for the upper and lower briquetting punches and for the sizing "knockout."

Mechanical presses are used for parts requiring low tonnage and hydraulic units for high tonnages. Economy usually dictates a mechanical press for small parts and a hydraulic press for large, even though the latter is slower, less adaptable and often more costly.

The Use of Vacuum

A special vacuum technique to aid the flow of powders in pressing and to increase the density of compacts to a point nearer that of cast or forged material is advocated by Hardy.[18] Metal powders can be compacted to a greater extent in a vacuum, even though no great compressing force is applied. The density obtainable with very fine powder under normal atmospheric conditions can be obtained with only 1/5 the compressive force and power in a vacuum of 3 mm. of mercury.

Both vacuum and hot pressing were employed in some Swedish experiments on copper alloy compacts, reported by Rudorff.[19] The pressing was accomplished by filling the powders into copper tubes, evacuating to a high vacuum, weld-sealing the tubes, heating to the pressing temperature, pressing in a die at about 40 tons per sq. in., and later removing the copper tube.

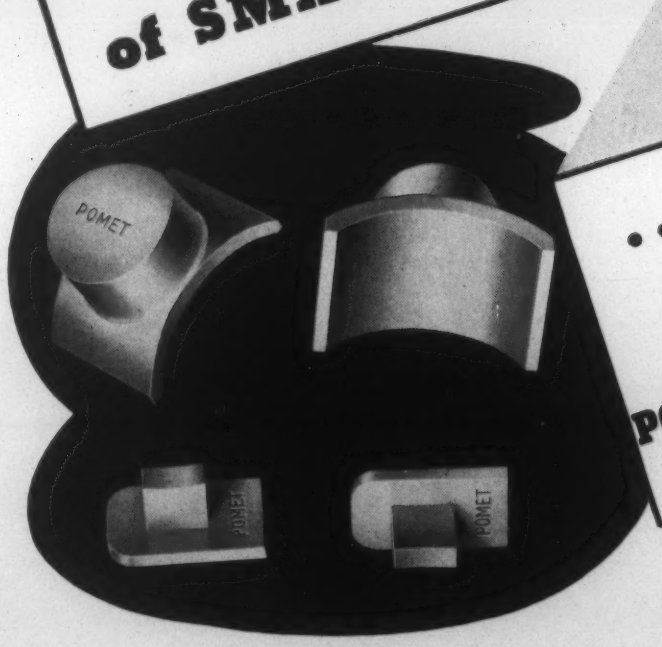
In the case of 6 and 10 per cent Sn alloys, the hot-pressed and sintered materials had much higher hardness and tensile strength than the corresponding cast materials. These hot-pressed alloys had densities 98.4 and 98.9 per cent, respectively, of those of the cast bronzes.

Another interesting use of vacuum is described by W. E. Kingston in the discussion of a paper by Kalischer.[20] Kingston's company makes radio tubes and parts, and in the production of nickel-aluminum alloys to be drawn into wire powder metallurgy is employed to circumvent melting problems. Furthermore, in milling, mixing, pressing and sintering elaborate precautions, such as the use of vacuum or inert atmospheres are employed to prevent oxidation of the aluminum.

The aluminum and nickel powders are ball-milled in an inert atmosphere (nitrogen). Compacts are then pressed and sintered in a large vacuum furnace. After the first stage of sintering, when the pressure has dropped to about 1 micron, hydro-

(Continued on page 1030)

If you want SPEED in the QUANTITY PRODUCTION of SMALL MACHINE PARTS



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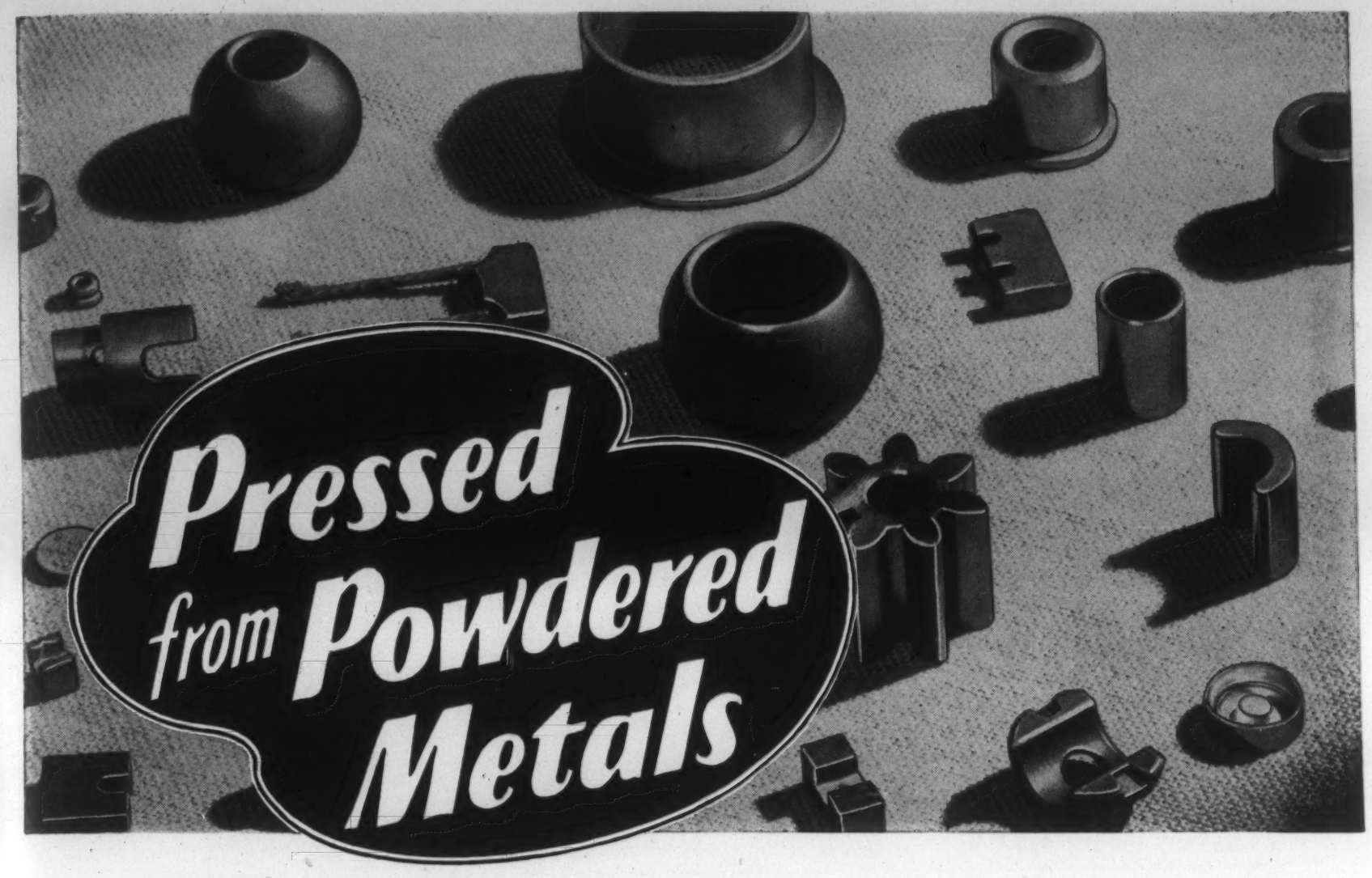

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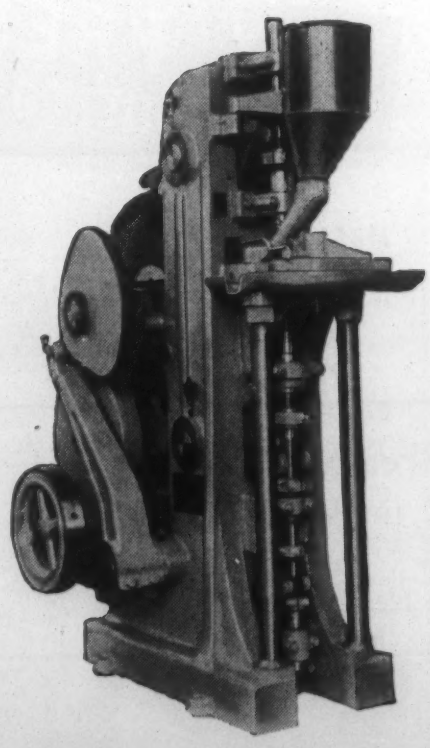

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gen or argon is admitted as the final sintering atmosphere. Ductile, oxide-free and compound-free alloys are thus obtained.

Fabricating Magnet Alloys

Kalischer's paper[20], just mentioned, is on the powder metallurgy production of iron-nickel-aluminum magnet alloys, with particular attention to pressing pressures, sintering time and prevention of oxidation.

Titanium hydride additions were made to the iron, nickel and iron-aluminum powder mixtures and appeared to be strikingly successful in producing a sound metallic bar nearly free of oxides. Magnets of good density can be secured by using forming pressures of 90-100 tons per sq. in., sintering temperatures of 2200-2350 deg. F., and sintering times of 20 hrs. or more.

In discussion Kelley points out that G.E.'s commercial practice on Alnico magnets is to use much lower pressures—around 30 tons per sq. in.—with entirely satisfactory results. Kalischer's justification for the higher pressure is that it permits a lower sintering temperature, with less shrinkage, warpage and operating cost.

Hotop[21] gets good results using pressures in the 20-60 tons per sq. in. range, although noting that Ritzau[22] considers the use of very high pressures imperative. Hotop, in addition to the usual powder ingredients for these magnet alloys, adds powder produced from scrap iron-nickel-aluminum magnets. He also favors the use of 50/50 iron-aluminum master alloys. His sintering practice is 1½-4 hrs. at 2425-2200 deg. F.

"Heavy Alloy"

The British General Electric Co.'s "heavy alloy"—a sintered copper-nickel-tungsten material—and the production factors that control its properties are described in great detail by Price, Williams & Garrard.[23] This article contains so much specific information on processing and properties that a really representative abstract of it is impossible; those interested should by all means refer to the original article.

In general, the material contains 90 W, 7.5 Ni and 2.5 per cent Cu, and in addition to its very high specific gravity (16.5-17), has a tensile strength comparable to that of a good quality steel. It is made by mixing tungsten, nickel and copper powders, pressing at 5-10 tons per sq. in., slowly preheating to 1800 deg. F. in a reducing atmosphere, and then heating the pressings at a higher temperature (high enough to form a liquid nickel-copper-tungsten phase).

Originally developed for radium containers, "heavy alloy" is now used for circuit breaker contacts and for machine-balancing weights (the material is quite machinable). Probably the major engineering application is as a material for mass balancing.

General

Of general interest and utility are an article by Greenwood[24] on the history and development of powder metallurgy and an A.S.M. committee report on powder metallurgy nomenclature published in *Metal Progress*.[25]

References

1 See, for example, F. P. Peters, METALS AND ALLOYS, Vol. 14, Oct. 1941, pp. 482-483.
2 W. D. Jones, *Engineering*, Vol. 152, Dec. 26, 1941, pp. 515-516.
3 F. C. Kelley, *Can. Metals & Met. Inds.*, Vol. 4, Dec. 1941, pp. 322-327.
Also in *Automotive & Aviation Inds.*, Vol. 85, Dec. 15, 1941, pp. 34-56, 58, 60.
4 R. Kalischer, *Iron Age*, Vol. 149, Feb. 5, 1942, pp. 41-46; Feb. 15, 1942, pp. 47-51.
5 Chas. Hardy, *Wire & Wire Products*, Vol. 17, May 1942, pp. 247-248, 257.
6 METALS AND ALLOYS, Vol. 12, Oct. 1940, p. 471.
7 METALS AND ALLOYS, Vol. 14, Nov. 1941, p. 721.
8 METALS AND ALLOYS, Vol. 14, July 1941, p. 63.
9 E. F. Cone, METALS AND ALLOYS, Vol. 14, Dec. 1941, pp. 843-850.
10 Joseph Geschelin, *Automotive & Aviation Inds.*, Vol. 86, June 1, 1942, pp. 28-31, 78, 80.
11 D. Basch, *Gen. Elec. Review*, Vol. 44, Dec. 1941, pp. 694-695.
12 Herbert Chase, *Automotive & Aviation Inds.*, Vol. 85, Dec. 15, 1941, pp. 35, 60.
13 A. F. Macconochie, *Steel*, Vol. 110, Mar. 16, 1942, pp. 98, 100, 117.
14 *Iron Age*, Vol. 149, Feb. 19, 1942, pp. 49-53.
15 J. Libsch, R. Volterra & J. Wulff, *Metal Progress*, Vol. 14, Apr. 1942, pp. 528-530, 540, 550.
16 P. Schwartzkopf & C. G. Goetzel. *Iron Age*, Vol. 148, Sept. 4, 1941, pp. 37-44.
17 A. J. Langhammer & M. F. Smith, *Metal Progress*, Vol. 41, Mar. 1942, pp. 335-337.
18 Chas. Hardy, *Steel*, Vol. 110, Jan. 19, 1942, pp. 84, 86.
19 D. W. Rudorff, *Metal Industry*, Vol. 60, Mar. 13, 1942, pp. 188-190.
20 P. R. Kalischer, *Trans. Am. Inst. Mining & Met. Engrs.*, Vol. 145, 1941, pp. 369-377.
21 W. Hotop, *Stahl u. Eisen*, Vol. 61, Dec. 4, 1941, pp. 1105-1109; abstract in *Nickel Bulletin*, Vol. 15, Mar. 1942, p. 34.
22 Ritzau, *Wiss. Veroff. Siemenswerke, Weckstoffe Sonderheft*, 1940, pp. 37-43; mentioned in reference 21.
23 G. H. S. Price, S. V. Williams & G. H. O. Garrard. *Metal Industry*, Vol. 59, Dec. 5, 1941, pp. 354-358; Dec. 12, 1941, pp. 372-374; Dec. 19, 1941, pp. 394-396.
24 H. W. Greenwood, *Metal Industry*, Vol. 60, Feb. 6, 1942, pp. 112-114.
25 *Metal Progress*, Vol. 41, Jan. 1942, pp. 44-46.

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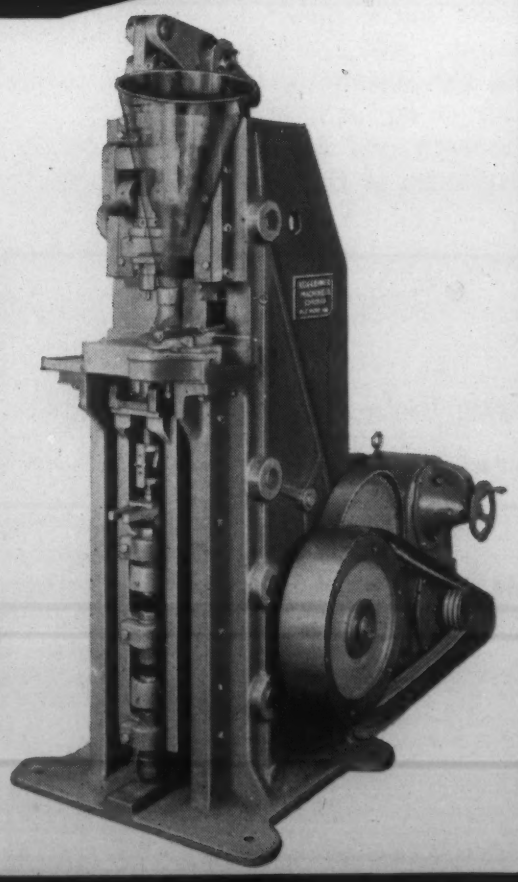

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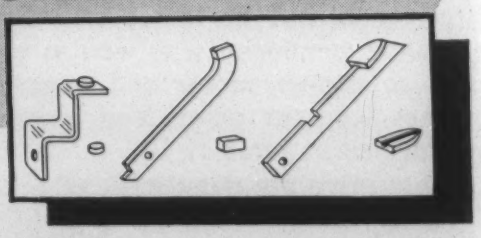

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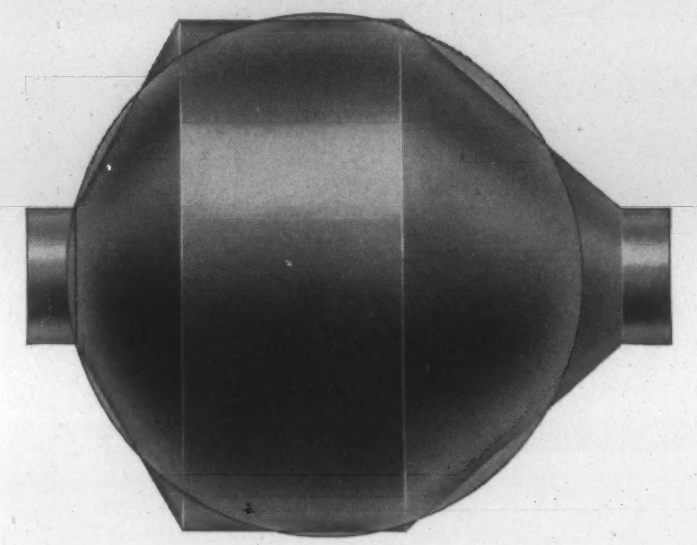

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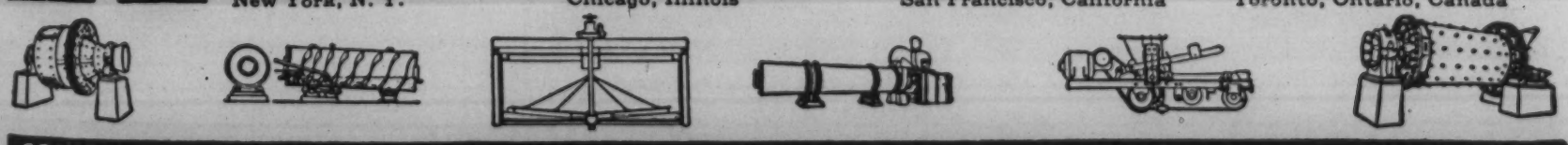

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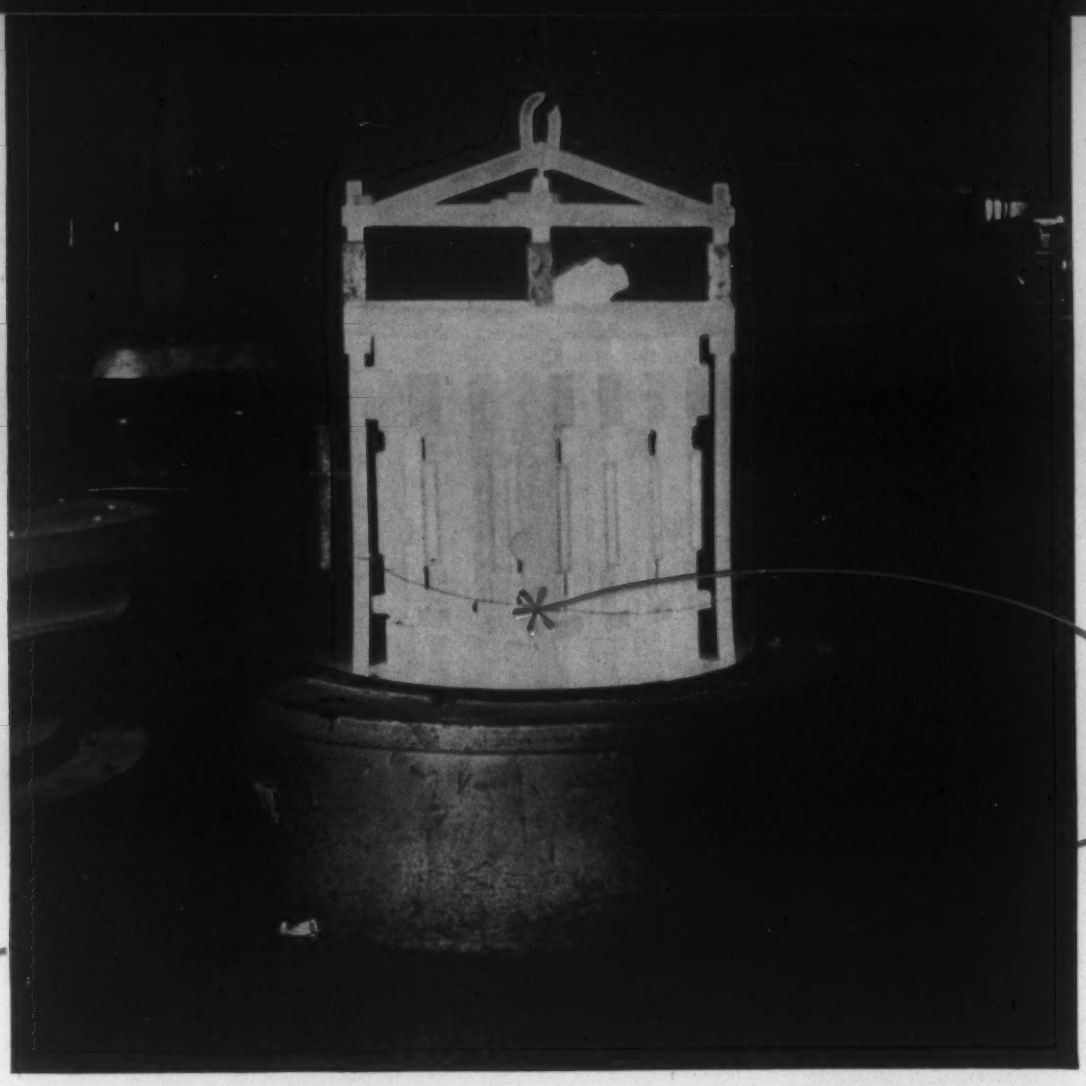

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BRINGS ALL THE ADVANTAGES OF 100% FORCED CONVECTION HEATING IN THE ANNEALING, NORMALIZING, AND HARDENING RANGES

THE 250° F. to 1750° F. temperature range of the Super-Cyclone, with the heating and control accuracy within that range, combines a hardening, normalizing, annealing, tempering, and nitriding furnace into one.

A typical example of the furnace's versatility is the normalizing job shown in the above illustration. These forgings are SAE 3450 and weigh 126 pounds each. The heating cycle starts with 12 of these forgings (1512 lbs.) loaded on a fixture, heated to 1650° F. in the Super-Cyclone, removed, and air cooled to 400° F. On the same fixture, they are charged into the Super-Cyclone again and heated to 1500° F., held 1 hour at this temperature and then oil quenched to 400° F. The charge is then put back into the same Super-Cyclone for tempering at 1100° F. and held for 4 hours. The entire operation is done in the one Super-Cyclone without handling the forgings, once they are placed on the fixture.

The previous method of handling was to heat these forgings in a radiation type box furnace. The capacity of the box furnace was 5 pieces. Time to heat them to 1650° F. required 5 hours, which included 1 hour for soaking at that temperature.

Normalizing in the Super-Cyclone, 12 forgings are heated in 2½ hours, including the soaking time of 1 hour at 1650° F. This is a production increase nearly 5 times greater than the old method of heating.

The forgings from the box furnace required straightening after the heating operation, whereas the 100% forced convection heating principle of the Super-Cyclone in minimizing distortion, produces straighter work, thus eliminating extra handling time for straightening as previously required.

With the box furnace, 2 men were required to handle the forgings individually in loading and unloading the furnace. In the Super-Cyclone, once the fixture is loaded, one man can handle the 12 forgings through the entire heating operation.

This Super-Cyclone normalizing, hardening, and tempering job is typical of the furnace's flexibility and the savings available through greater production, reduced handling time, and straighter work.

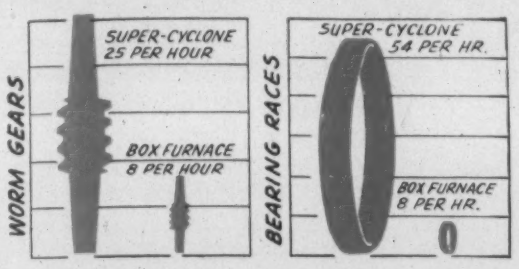
SUPER-CYCLONE QUENCHING

When the first Super-Cyclone was being designed, Lindberg Engineers anticipated the obvious problem of mass quenching of heavy loads and devised equipment to take care of the situation. A typical example is the 1512 lb. load of forgings shown in the illustration above, which is heated and quenched, fixture and all. Jobs similar to this are being quenched with perfect results, every day, in plants all over the country.

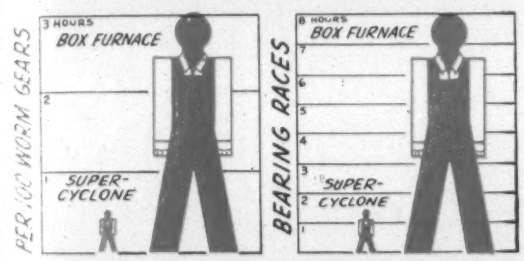
Heat treaters who have seen the Super-Cyclone in action, quickly appreciate that to secure all the advantages of which the furnace is capable, the quench must be looked at from an entirely new standpoint. This involves quench tank size, oil velocity, volume of oil, cooling, and storage.

Twenty-one months of production experience in our own plant and in the field, with nearly 200 installations, have enabled Lindberg Engineers to work out an accurate formula which greatly simplifies this problem.

SUPER-CYCLONE INCREASES PRODUCTION because work is stacked up or piled up on a fixture, rather than laid out in one layer as in conventional equipment. The 100% forced convection heating principle of the Super-Cyclone then brings the work to temperature rapidly, accurately, and uniformly. The charts below show Super-Cyclone production increases over radiation type box furnaces which were previously used on these bearing race and worm gear jobs.



SUPER-CYCLONE REDUCES HANDLING TIME. With a temperature range from 250° F. to 1750° F. and accurate control therein, the Super-Cyclone is a flexible unit for any heating operations within that range. The forgings on the opposite page are normalized, hardened, and drawn, in the same Super-Cyclone, on the same fixture, effecting a substantial reduction in handling time. The charts below, represent a handling time comparison between the Super-Cyclone and the radiation type box furnaces that were previously used on these bearing race and worm gear jobs.



SUPER-CYCLONE KEEPS WORK STRAIGHTER. The 100% forced convection heating principle prevents distortion by eliminating any possibility of radiant heat striking the charge. Heated air is driven through the charge at high velocity, resulting in a rapid, uniform, and accurate heat. With distortion reduced to a minimum, valuable man hours are freed from the straightening press for use on other work. It might be noted that the above chart does not include an additional 7½ hours handling time for straightening the 100 worm gears from the box furnace.

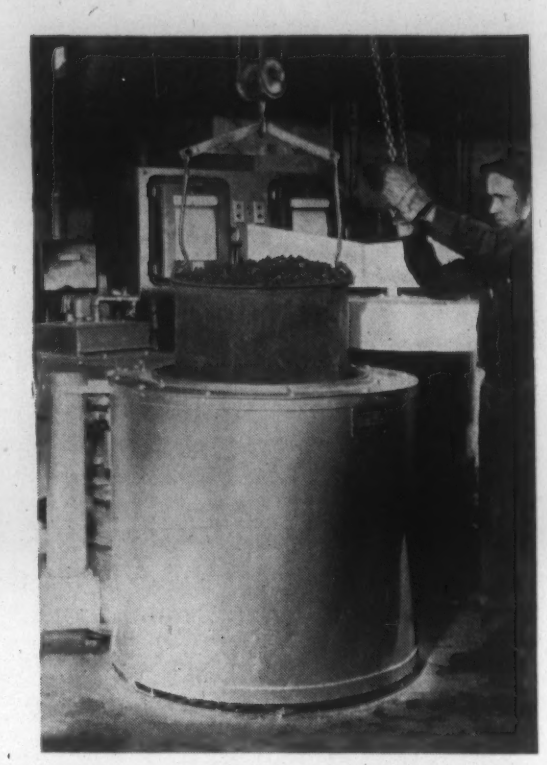
IMPORTANT NOTE: Like all other Lindberg developments, the Super-Cyclone has been thoroughly proved under 24 hour a day production conditions for a minimum of 12 months before announcement to the trade. To date, nearly 200 Super-Cyclones are in service from coast to coast. One or more of these installations is near you, as is a Lindberg District Office, staffed by practical and competent sales engineers. The Super-Cyclone is *not* a cure-all, nor do we represent it as such, however, it is speeding production, turning out straighter work, and cutting costs for many firms. We will be glad to survey its possibilities for you, on your work, at your request.

CYCLONE FOR TEMPERING

Here is the production proved tempering furnace that can help you meet today's toughest production schedules. Thousands of Cyclones are now employed all over the country for low cost, accurate tempering, annealing, and stress relieving. The Cyclone, with a temperature range of 250° F. to 1250° F., increases production, reduces rejections through accurate heating control, and cuts operating costs.

Employing the 100% forced convection heating principle, the Cyclone increases production by heating the charge rapidly and uniformly. The work is soaked in heated air that is recirculated through the charge under pressure. The Lindberg Throttling Control adjusts the input of heat to meet the requirements of the load, thus assuring accurate temperature control, hardness tolerances of plus or minus 1 Rockwell "C", and reduction of operating costs.

Lindberg Cyclone Tempering Furnaces are available in a wide range of standard sizes of the vertical or box type, electric or gas fired. For more specific information may we suggest you write for bulletin Number 53—Gas Fired Vertical, Number 13—Electric Vertical, and Number 62—Electric Box Type, or phone your local Lindberg representative, who will be glad to demonstrate the advantages of this low cost, accurate tempering furnace.



Whether the charge be a dense load of bolts, as shown above, or large pieces of heavy section, the Cyclone Tempering Furnace's 100% forced convection heating principle heats them rapidly and accurately, holding them to extremely close hardness tolerances.

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NO SCALE
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Maximum production runs of punches, dies, and other tools can be obtained with the scale-free, decarb-free, and carburization-free hardening of Hydryzing. The neutral, controlled atmosphere of the Hydryzing Furnace is fool-proof, and easy to regulate to meet the needs of all types of steel. It turns out work that is clean and hard, right on the surface, thus eliminating the need for costly grinding, stoning, or polishing.

The products necessary to produce the neutral Hydryzing atmosphere, charcoal, anhydrous ammonia, and benzol are readily procurable in any locality, thus forestalling any production delays due to the need for special equipment.

The standard Hydryzing Furnace is built in a wide range of sizes from heavy production types to tool room furnaces. It is also made in Rotary Drum, Rotary Hearth, Tilting Hearth for bright hardening, and Conveyor types, to meet the requirements of various jobs.

More detailed information may be obtained on these controlled atmosphere furnaces by asking for bulletin Number 94.

Visible on the Hydryzing Furnace in the photo at left is the outside door curtain, the special replaceable door sealing gasket, the vestibule protection plate, and in the lower left hand corner, the foot pedal which controls the automatically operated door. The advantage of the outside door curtain, which is placed immediately below the chamber opening, is its greater transparency and ease of access for cleaning and maintaining.

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Arc Welding Stainless Steel

A Composite

The successful welding of stainless steel sheet presents many problems, particularly if the components to be welded must also be drawn or otherwise "severely" fabricated. (Some pointers to remember when welding and forming stainless steel exhaust manifolds are given in the article on p. 980 of this issue.)

From the welding viewpoint these alloys have one definite characteristic—their austenitic nature, by which they maintain the same basic structure from liquid to room temperatures; they cannot, therefore, be hardened by heating and cooling. E. W. P. Smith *(Iron Age,* Vol. 149, Apr. 2, 1942, pp. 57-62) discusses the characteristics of stainless steels and the best techniques for welding them.

Operating Practice

In arc welding chromium-nickel steels, currents lower than those used for ordinary steel are employed. In the case of a type 347 electrode, the average chemical analysis of weld metal will be 0.065 per cent C, 16.6 Cr, 9.5 Ni and 0.80 Cb. Welds can be ground and polished with good results.

Except when welding thin sheets at low current (below 30 amps.) the electrode should be positive and the work negative (reversed polarity). The procedure should be the same as with mild steel, except that the higher electrical resistance, lower thermal conductivity and high thermal expansion of stainless steel should be considered.

As short an arc as possible should be used without choking or sticking. Avoid excessive weaving. When making vertical and overhead welds, smaller size (up to 5/32 in.) electrodes with amperage in the low portion of the range are to be used. When welding the stainless side of stainless clad steel by the metallic arc method, the electrode should be positive and the work negative.

In the case of 18-8 steel, a 24 per cent Cr, 12 Ni electrode offers very good corrosion resistance. In welding sheets thinner than 3/16 in., it is advisable to use an electrode with higher alloy content than the material being welded.

When welding stainless to mild steel, where the mild steel back must be welded to the stainless face of the mating sheet, an electrode of 25-12 analysis is used. The weld bead is to be made in multiple passes to minimize dilution of the weld bead.

Amperage should not be excessive. When welding lighter gages of stainless clad, chill bars are to be used where possible, in order that cooling is rapid. The mild steel side should be welded with multiple beads to avoid overheating the stainless surface. A general-purpose shielded electrode is used for the mild steel.

Proper design before welding is essential. Joints should be so designed that iron pick-up will be minimized and localized. Where the steel is exposed, as in the case of lap and corner welds, the stainless weld should be in several layers.

Stainless may be welded automatically by using a carbon arc. The carbon arc provides the heat, the flux is independently controlled (as is the speed), and the filler metal is added as required. Automatic shielded carbon arc machines are designed to automatically strike the arc, feed the carbon electrodes, shielding material and filled strip, maintain a constant arc length and rotate the carbon electrode.

Avoiding Cracking

A satisfactory welding method is needed to replace the stringer bead method of welding type 304 stainless steel. E. P. Auler *(Welding Journal,* Vol. 21, Feb. 1942, pp. 98s-106s) describes an investigation to develop a technique that will avoid cracking.

The experimental base method used in these tests was "18 and 8" containing 0.05 per cent C and 0.25 Si, annealed at 1950 deg. F. and water quenched before welding.

Welding electrodes with 0.07 per cent C maximum obtained from various manufacturers were employed. Two electrodes contained 0.75 per cent Cb.

Some tests were made with water-quench between each pass, air-cool between passes and with stringer beads and full width weaving. Seven different groups of tests were of welding conditions and macrographs of the completed welds are shown for one cross section from all of the welds. After welding, tests were made to determine the effect of re-annealing at 1950 deg. F. of water-quench and of reheating at 1200 deg. F. after annealing.

Crater cracking was not encountered, but it was found that stringer bead deposits are more susceptible to cracking than weaving deposits, provided the weaving does *not* become so excessive as to cause crater cracking. Welding time is also greatly reduced by the use of weaving beads.

Carbide formation in the weld will not occur in arc-welded, type 304 "18 and 8" regardless of the welding procedure, provided the weldment is kept reasonably cool. One of the two columbium-stabilized electrodes from two different manufacturers showed severe cracking in the weld deposit when joint was welded under restraint.

Painting Structural Steel

Condensed from an Iron & Steel Institute Paper

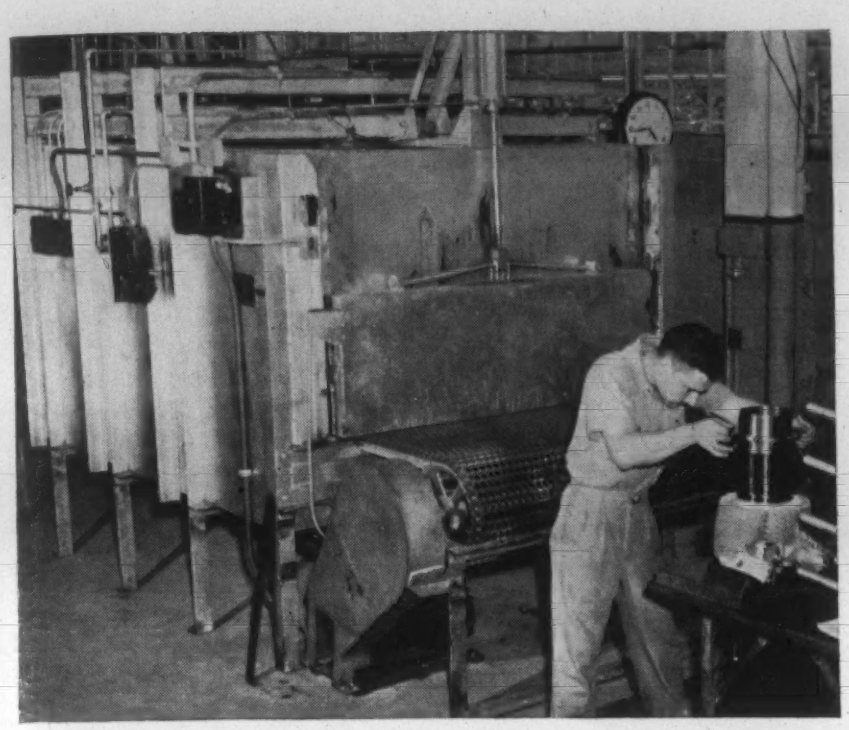
For maximum durability paint should be applied over a surface that is completely freed from mill scale and rust. It is detrimental to let the surface rust after the removal of mill scale or rust. Painting over a complete film of mill scale may give good durability in some cases.

The life of paint applied over a surface from which mill scale and rust have been incompletely removed will be less than for paint applied to really clean surfaces. Mill scale and rust can be removed by pickling or by sandblasting. A corrosion-inhibiting primer, such as red lead, should be used.

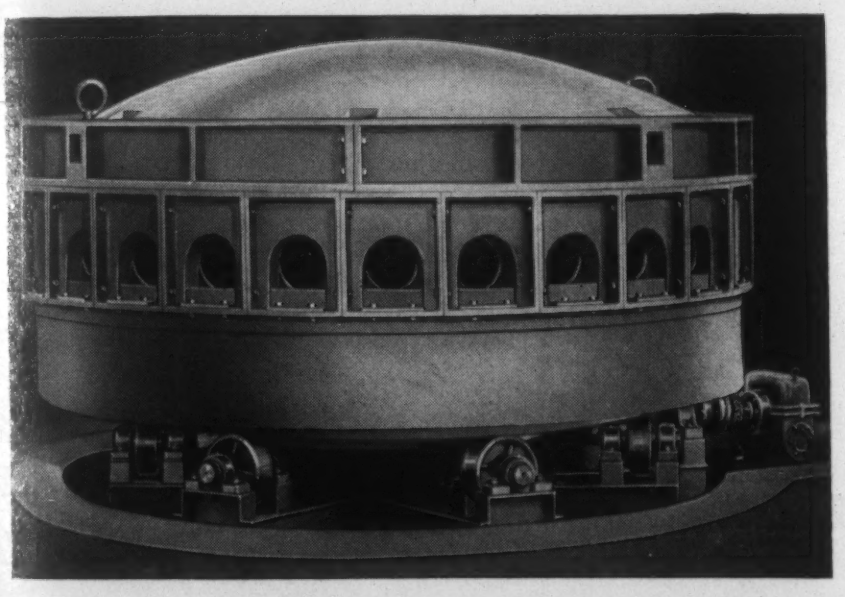
It is claimed that if the painting of new steel structures is carried out in accordance with these principles the saving in maintenance will more than repay the cost of surface preparation before painting.

—Protective Coatings Sub-Committee, *Iron & Steel Inst.*, Adv. Copy, Dec. 1941, 14 pp.

If you heat treat metals INVESTIGATE



Above—A MAHR continuous type furnace used in a large aircraft engine plant for heating aluminum heads to 470°.



Above—A MAHR center fired, rotary shell nosing furnace in use for many months giving steady, satisfactory performance.

Below—Modern, high speed shell hardening, quenching and drawing furnace for 75MM, 90MM, 105MM, 155MM high explosive shells.

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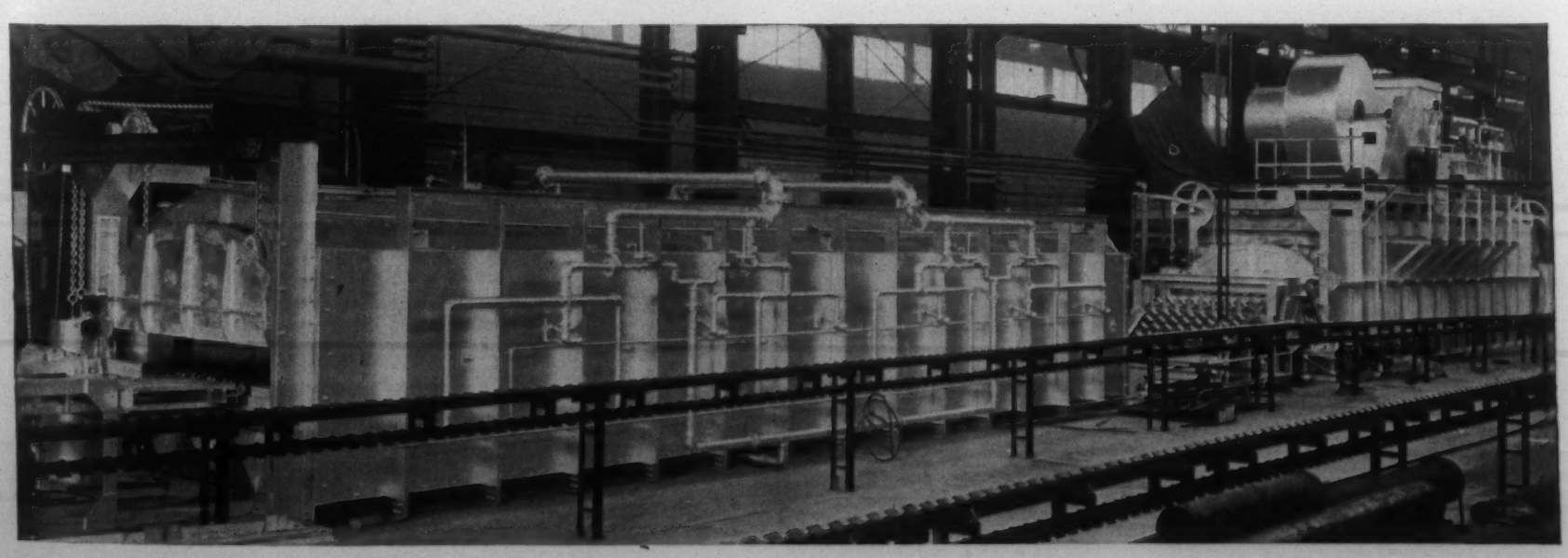

Heat Treatment of Rails

Condensed from
"Bull. Am. Railway Engrs. Assn."

This is Prof. H. F. Moore's eighth progress report on fissures in railroad rails.

Properly controlled-cooled rails, or those held several hours at a temperature above the range in which shatter cracks develop and then normalized (improved Brunorizing process) continue to show satisfactory freedom from fissures in service. The controlled cooling method has been revised so that temperature control is done by a couple in the bottom layer of rails, where the temperature may not drop below 300 deg. F. in 7 hrs. The total cooling time is 10 hrs., a shorter time than that previously specified.

All the end-hardening processes used markedly reduce end batter. When a slot was ground between tight rail ends to make room for the beveling wheel, in rails with ends hardened to over 400 Brinell, fatigue cracks developed in service, originating in rough grinding marks, and starting below the rail surface.

These cracks take in water, and water and rust exude from them under wheel pressure, hence they are termed "weeping cracks." The cracks progress both by fatigue and by corrosion fatigue.

Asphalt coating of the ends to prevent corrosion, grinding without producing too great roughness, and holding the Brinell below 400 are all advocated. Where these precautions have not been taken the cracks will ultimately require that the rail ends be built up by welding.

Drop and bend test methods for rails have been studied, and will be further developed. Field tests on batter and further study of cooling conditions in control-cooling containers are also on the 1942 program.

—H. F. Moore, *Am. Railway Engrs. Assn. Bull.*, Vol. 43, No. 430, Feb. 1942, pp. 607-640.

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Drop Forging Aircraft Parts

Condensed from "Steel"

For forgings produced by upsetting under a drop-hammer, the stock must be cut into individual lengths for each forging. Sawed rather than sheared stock is preferred for forgings made by a simple upsetting operation, such as gears and bevel pinions, since the truer billet is obtained and there is less likelihood of offsetting the grain flow in upsetting.

Forgings that do not require upsetting can normally be made straight from the bar. Generally, steel forgings are produced at temperatures above the Ac_3 point.

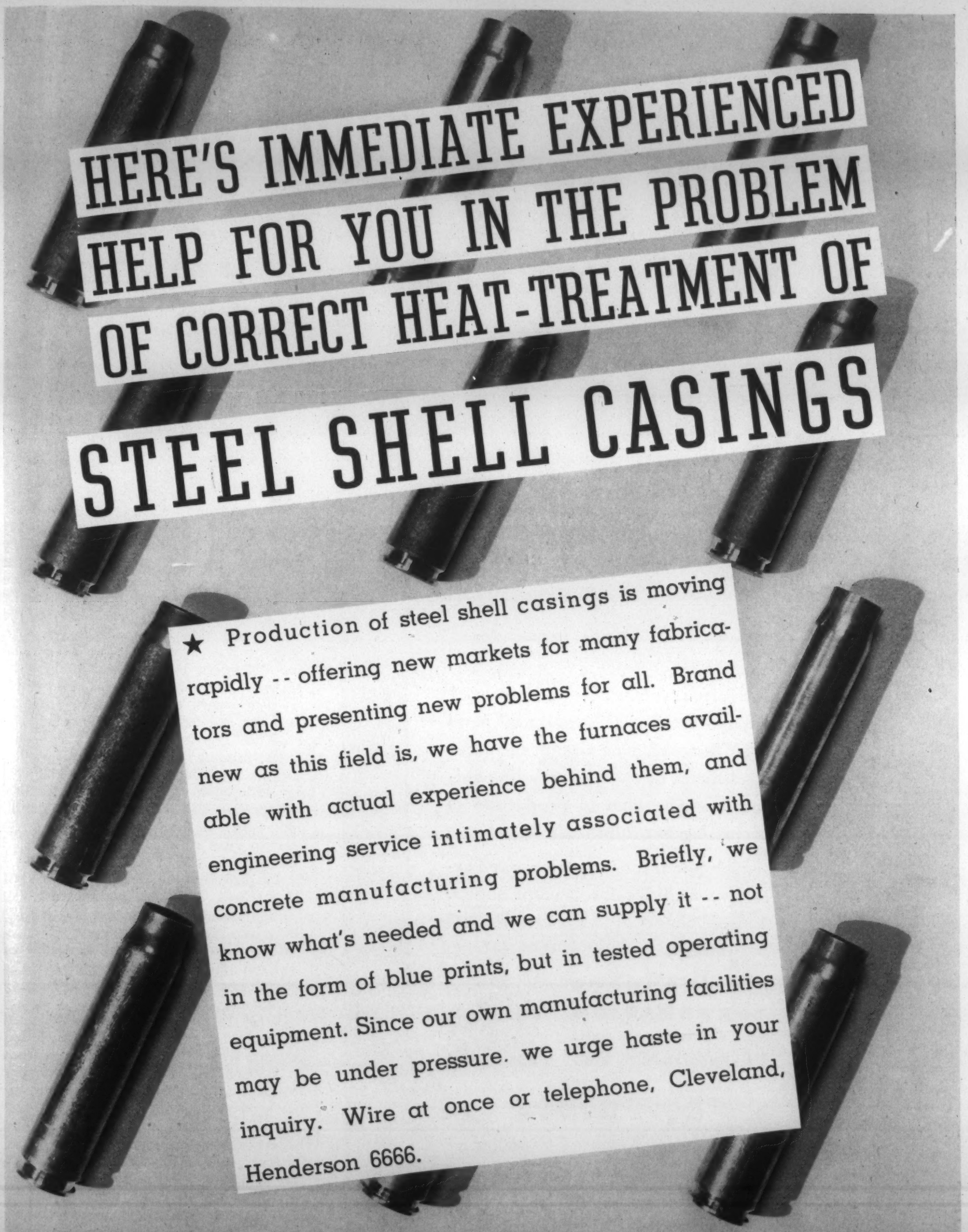
With a drop-hammer, the work done depends on the energy of the original blow and since a number of blows are usually required to produce the desired deformation, plastic flow is erratic. With a hydraulic press or an upsetter, the work done depends more on the ultimate pressure, and the metal flow is smooth and uniform.

The impact pressure of drop-hammer tends to break down the structure to a greater extent than the more uniformly applied pressure of a hydraulic press or upsetter, but dangers of excessive reduction are increased because this erratic flow is also more likely to break up the fiber structure. If the impact pressure of drop-hammer is too light, flow may occur at the surface but not at the center of the piece.

At slow rates of deformation, carbon has little effect on resistance to flow. With high rates of deformation such as in drop forging, the resistance to flow increases with carbon content. Alloying elements, particularly chromium, also tend to increase resistance to flow.

The rate of application of pressure is a function of the strength of the metal at high temperatures and is important. Generally, metals behave as though they were harder under the hammer than under the press owing to the element of time involved in the flow of metal, and it is possible to work at lower temperatures with slow loading. Magnesium alloys must be worked slowly under a hydraulic press, whereas many aluminum alloys have a finer grain structure if worked at high speeds. The chilling effect of dies is important with large forgings, but has little influence in the production of small aircraft forgings. Surface resistance between the hot metal and die results in abrasion of the die by the metal.

Oil-quenched and tempered nickel-chromium-molybdenum steel die-blocks are superior for drop-forging dies as they com-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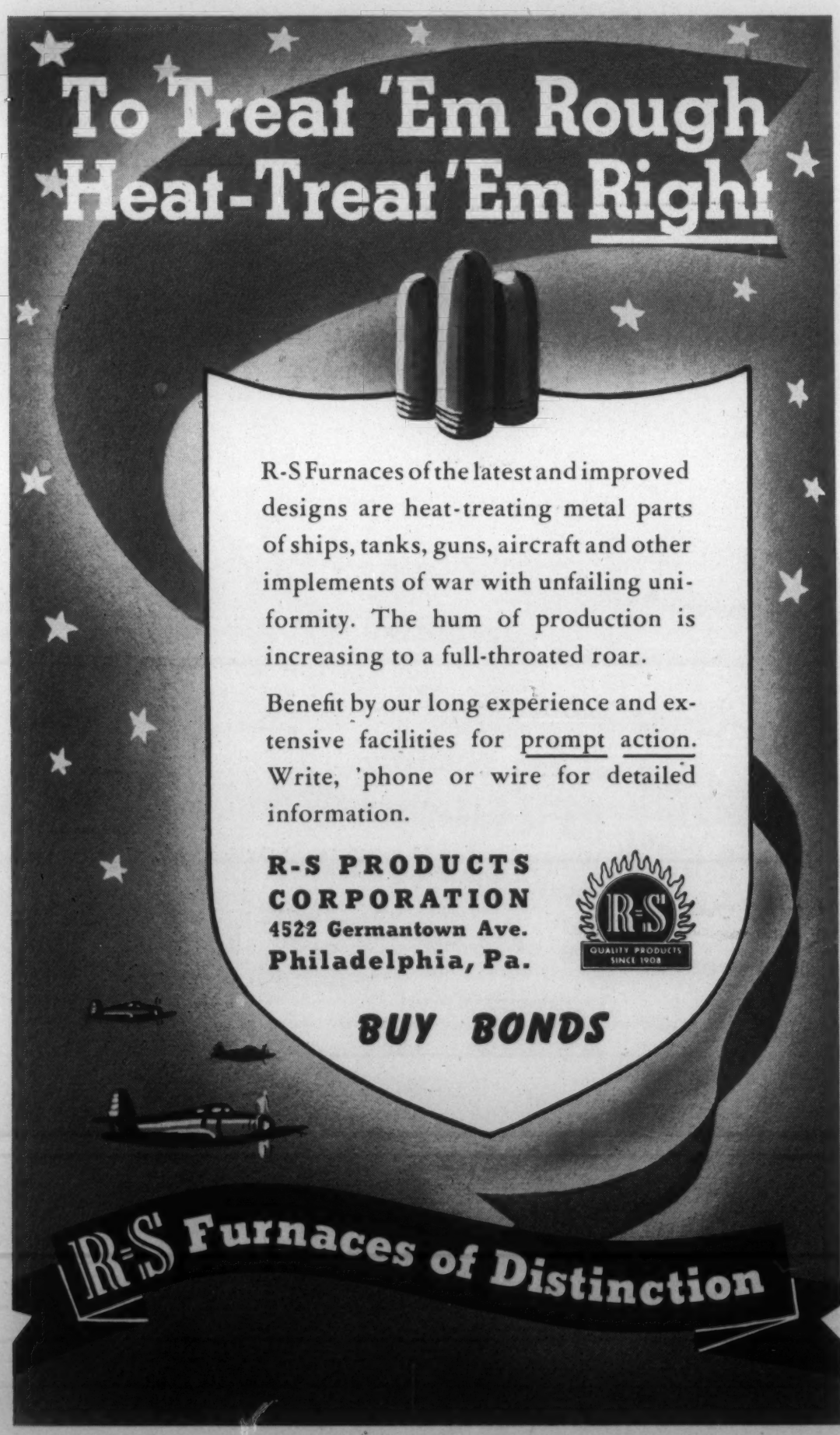
bine maximum abrasion resistance with excellent resistance to shock. Vanadium is often added to give a fine-grained dense structure. Harder tempers are used where abrasion resistance is of chief importance; softer tempers are used for preventing checking of intricate dies with deep impression.

One of the most important factors in production of good quality forgings is amount of forging reduction. Generally, a forging reduction of 8:1 is satisfactory for drop forgings.

Tests show that while properties of the forging in the longitudinal direction improve with extra reduction, ductility and impact resistance in the transverse direction deteriorate. Inclusions that have been elongated by forging act as holes in their effect on transverse properties. The greater the reduction, the greater the elongation of the inclusions in the direction of flow and the greater the effect on the transverse properties.

Because of this difference in directional properties, great pains are taken to produce correct grain flow in aircraft forgings. Care should be taken to insure that the flow lines are not broken during forging and that subsequent machining will not cut the flow lines where such interference will affect the strength. Accurate control of temperature during reheating, soaking, and forging is important, as are rate of reheating and time of soaking. Generally, it is desirable to work at temperatures such that forging is completed while work is at a temperature not too high above the Ar_3 point.

—A. H. Milnes, *Steel*, Vol. 110, Mar. 9, 1942, pp. 64-66, 105; Mar. 16, 1942, pp. 68-69, 117; Mar. 23, 1942, p. 79.



Salvaging Worn Parts

Condensed from "S. A. E. Journal"

Metal spraying and hard surfacing are convenient and practical means for salvaging automotive parts.

It is important that sprayed parts will not be stressed excessively and that no fatigue cracks exist in the base piece before spraying. Preparation of the base should assure keying and dovetailing deep enough to withstand the mechanical pressure involved. The base must be clean and free from oxides, oil, dirt, and moisture.

Metallizing

The sprayed metal must be finely atomized. Anchorage for the coating may be prepared by abrasive blasting or by special knurling or grooving tools. By the cooling and contraction of the successive layers of sprayed metal, the entire coating is tightened on the base piece in the same manner as a sleeve is shrunk on a shaft. This action tends to weaken the bond between the base and the sprayed materials when coatings are applied to inside diameters, unless special preparation and spraying technique is provided.

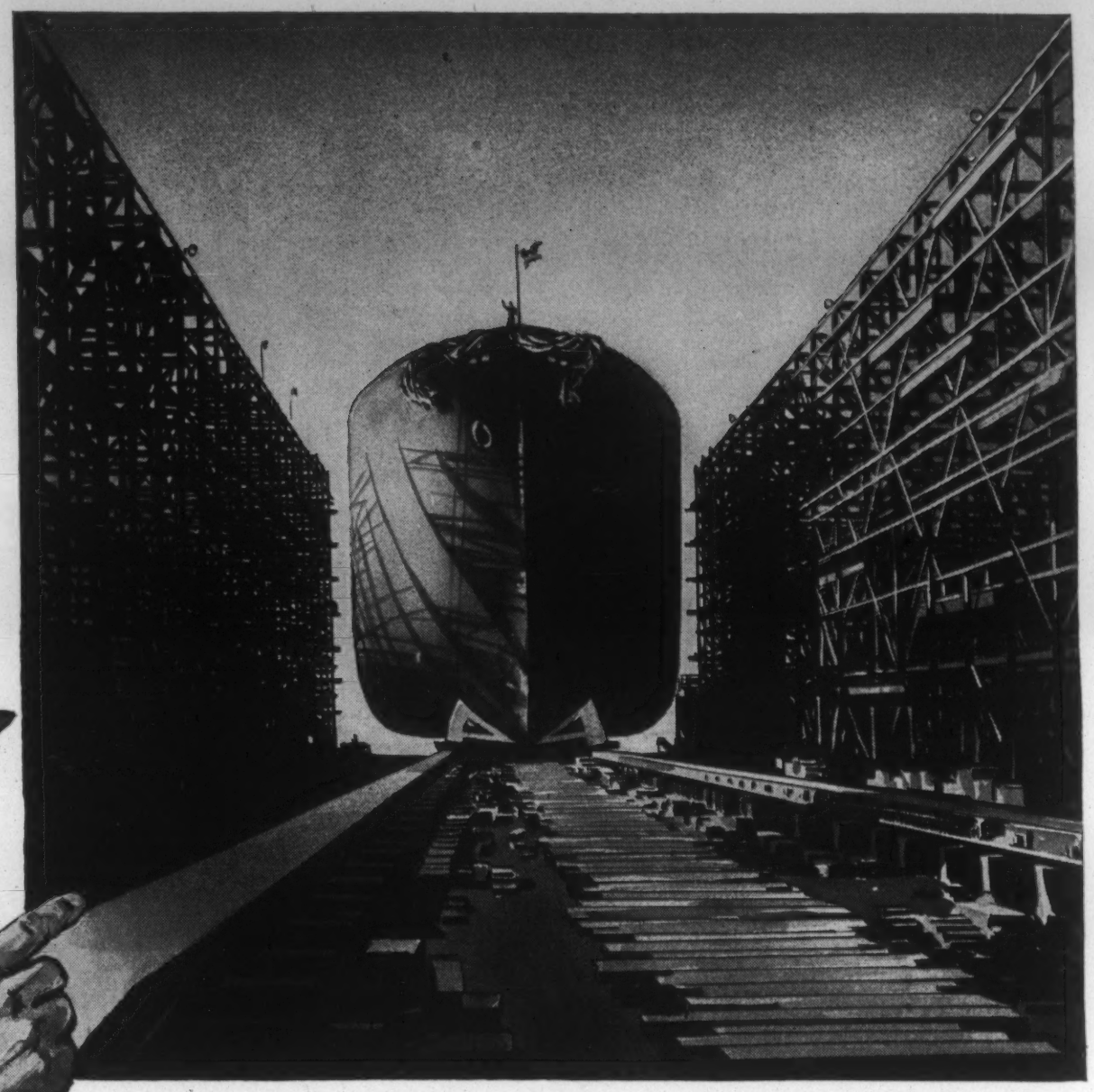
When spraying on flat surfaces, special attention must be given to the preparation of the edges of the base, the thickness of each layer applied, and the selection of spraying materials with definite ductile properties. In some cases, it may be necessary to spray a ductile metal first and bond the desired metal to it.

In preparing the outside diameters of shafts, rods, and worn bearing areas, the surface should be undercut to provide a smooth area for the keying or dovetailing and to insure a finished coating of uniform thickness and strength. The coated area should be finished by turning or grinding.

When coating shafts, they are mounted in a lathe or other rotating device on centers, with the nozzle of the gun about 6 in. from the surface of the work. For pieces 2 in. or less in diameter, the rotating speed is about 35 ft. per min. and the passing speed of gun should be not more than $\frac{1}{8}$ in. per revolution. For larger speeds a surface speed of 50 ft. per min. and carriage speed of 1/6 in. per revolution are satisfactory.

If lighter coats are desired, both surface and carriage speeds are increased proportionately. Speeds for inside diameters are about 75 ft. per min. for surface and 1/6 in. per revolution for gun. Most flat surfaces are sprayed by hand.

Many worn areas can be restored successfully. Improvement of wearing quality or corrosion resistance may be made by substituting a suitable metal. Sprayed metals have a porous structure which re-



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THINK OF IT! — an average of 35 linear miles of welding to complete the hulls of the new cargo vessels that are coming off the ways so rapidly! Such tremendous footage indicates the need for the machine which makes welding easier, faster — and assures more uniform results.

To speed production is one reason why P&H-Hansen Square Frame Welders are being more generally used in ship-building and other important industries. Another is to gain these important advantages:

1. **Single current control** with automatic arc response for all classes of work.
2. **Square frame design** which permits machines to be operated singly, or in parallel to meet all amperage requirements.

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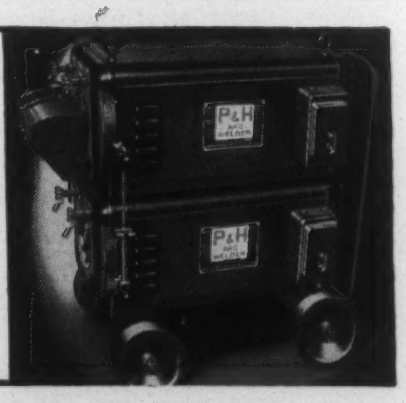

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● Whatever your problem in welding alloys, P&H can help you. The complete P&H line includes electrodes for welding all analyses of stainless steels, special electrodes for hard surfacing, resistance to impact and resistance to abrasion as well as for welding various types of armor plate, etc.

Write for literature.

tains lubricants, thereby reducing wear even under heavy loads.

Wire size, type of gas, and pressures used affect spraying costs. Generally, the larger the wire used, the greater the spraying speed and the lower the cost. Exceptions are the stiffer wires that may slow down under load, and in spraying small pieces where edge loss may be excessive because of the greater cone of spray in larger wires.

Although acetylene costs more per cu. ft. than propane and a greater volume per lb. of metal is used, the ratio of oxygen to acetylene for normal flame is 2.5:1, while a 6.4:1 ratio is required for propane so that the oxygen cost may be the determining factor. While increased spraying speeds result from increased gas pressures there is a point at which the cost of increased gas consumption exceeds the gains involved. The Fire Underwriters' operating pressure limit for acetylene in some localities, is 15 lbs. per sq. in., while there is no limit on propane pressures.

Water-pump shafts have been sprayed with stainless steel and finished to the original dimensions at ⅓ the cost of a new shaft. Brake cam-shafts can be sprayed at about ⅓ the cost of new shafts. Six throws of an engine crank-shaft can be sprayed and finished for less than ½ the cost of a new shaft.

Hard-Surfacing

Non-ferrous alloys are used almost exclusively for hard facing against abrasion. It is economical to build up worn areas with ferrous alloys and to use non-ferrous alloys for surface hardness only. The hard-facing non-ferrous alloys have excellent welding properties: Hardness comparable with that of hardened steel, which is retained at high temperatures; low coefficient of friction and tendency to take a high polish, which increases the life of other metals working in contact with them; and a coefficient of expansion similar to that of steel which results in freedom from shrinkage cracks when these alloys are applied to steel.

Tungsten carbide is sometimes used for hard-facing as inserts, a ferrous alloy being used for binding. Hard-facing may be done by almost any standard fusion method. However, for certain applications, the oxyacetylene method is preferred. For large surfaces, the metallic arc process is recommended, but there will be a dilution with base metal, which reduces abrasion resistance of facing in most cases.

The area to receive hard facing should be free from rust, scale, and other foreign matter. These should be removed by grinding, machining, or chipping. If other cleaning methods are used, a bright surface free from oil and dirt is necessary. Preheating, if required, should be done in a furnace or by neutral oxyacetylene flame. A number of automotive parts have been hard faced, with a resulting increase in life ratio—in some cases as high as 10 to 1.

—W. J. Cumming, *S. A. E. Journal*, Vol. 50, Apr. 1942, Trans. pp. 139-140.

Weld-Cracking of Chrome-Moly Steel

Condensed from "Trans. Inst. of Welding"

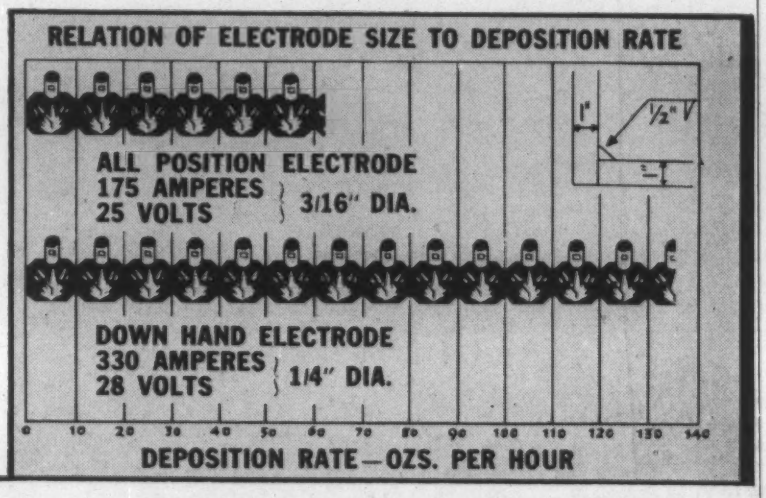
Several German attempts to determine the cause and cure of cracking have recently been described. Special methods of deoxidation and an active boil in the furnace are reported to be successful in reducing or entirely eliminating the crack sensitivity of the steels.

The crack sensitivity appears to depend also on the method of welding; the oxyacetylene torch produces greater sensitivity than the atomic hydrogen method. The elements carbon, manganese phosphorus and sulphur have individual and interrelated effects on sensitivity. Carbon and sulphur appear to be most effective in modifying and increasing sensitivity.

Among the postulates as to the cause of cracking are hydrogen sulphide generated by the reaction of hydrogen in welding gas and sulphide, the generation of internal stresses by water formed in the reaction of acetylene and iron and manganese oxides, the low strength of segregated non-metallic regions, and internal pressure due to entrapment of molecular hydrogen. None of the postulates is completely satisfactory as an explanation of sensitivity to cracking. However, the presence of segregated non-metallic eutectics, and their fusion in the base metal next to the weld, causing local low strength and cracking appears to be the most plausible.

—J. G. Ball, *Trans. Inst. of Welding*, Vol. 4, Oct. 1941, pp. 181-187.

SUGGESTIONS TO HELP SPEED WELDED FABRICATION AND RELIEVE THE ELECTRODE SHORTAGE



In spite of the construction of new plants and tremendous increases in production, there is still a very definite shortage of welding electrodes.

The smaller sizes of electrodes and those of the all-position type cannot be manufactured as fast as the larger sizes and those with all-mineral coatings.

Electrode users can, therefore, help relieve the electrode shortage by using sizes as large as practical and by planning their work, so that whenever possible the all-mineral coated rods can be specified.

Using the larger diameter electrodes increases the speed of fabrication, too. For normally, when proper currents are used, the greater the electrode diameter, the higher is the resulting deposition rate. As shown in the above chart, in joining 1" plate with a ½" fillet weld, a 3/16" all-position rod deposits only 62 ounces of metal per hour, whereas a ¼" downhand "hot" rod at 330 amperes, deposits 135 ounces per hour, an increase of over 117%.

Murex engineers are available for consultation to manufacturers who are directly or indirectly engaged in war production—whether or not they are users of Murex electrodes.

Specialists in welding for nearly 40 years. Manufacturers of Murex Electrodes for arc welding and of Thermit for repair and fabrication of heavy parts.

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A TYPICAL PERFORMANCE—Firthite Cutters, with 10° negative rake and 10° negative spiral (helix) angle, are operated up to **10 times the speed** with resulting **6 times the feed** of high-speed steel mills—on hardened, alloy-steel parts. (Ordinary cutters with carbide tips proved impractical on this job.) Firthite Tips in "Hyper-Milling" Cutters solved the problem!

"HYPER-MILLING" may solve that tough, steel-milling job in YOUR shop . . . **details on request.**

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Built-Up Cutting Tools

Condensed from "American Machinist"

High-speed tool steel can be conserved by reserving it for cutting edges of built-up tools. Lower-alloy steels, carbon steels or high-strength cast iron can be used for shanks.

Countersinks, for example, may utilize high-speed cutting tips and mild steel shanks with considerable saving in scarce materials. In making this type of tool, care should be taken to bore out the back end of the cutting tool proper so as to fit snugly on the large or unthreaded section of the shank.

Another kink involves a taper shank boring bar with a flat-speed steel blade. An elongated slot is cut through the holder to take the cutter and a tapered wedge is used to lock it securely. The pilot end of the holder has semi-circular flutes milled around the periphery for dirt and chip clearances.

This is especially useful in machining cast iron. After they are machined the holders are heated to 1500 deg. F., quenched in oil and drawn in a salt bath at 900 deg. F.; the extreme pilot end is not drawn quite so much. Good torsional strength is thus imparted to the holders.

Welding can be employed successfully for more economical use of material. In hardening welded tools, preheating is important. The practice of trying to harden high-speed steel without the use of a pyrometer should be discouraged.

Homemade tools will fail in service unless careful attention is paid to tooth forms, avoiding sharper corners wherever possible. Periphery clearances should be provided; if the right cutters are not available for milling the clearance, a reasonably good job can be done with a file.

P. L. Budwitz, *American Machinist*, Vol. 86, Apr. 30, 1942, pp. 384-385.

Tinning Aluminum Pistons

Condensed from "Products Finishing"

Tin coating of aluminum by the immersion method has been used primarily on aluminum pistons as a preventive against scuffing and to reduce engine break-in time by providing lubricating qualities.

Pistons are cleaned after machining by dipping into a solution of 3 oz. per gal. of trisodium phosphate at a temperature of 175-185 deg. F. They are removed from the solution as soon as gas bubbles form on the aluminum. Longer cleaning etches the surface and causes blistering of the tin deposit. The pistons are then rinsed in cold water, dipped for about 30 secs. into 3% nitric acid solution, and rinsed in cold water.

To produce the tin coating, the pistons are dipped in a bath containing 6 oz. per gal. of sodium stannate for a length of time depending on the desired thickness of coating. Four minutes is required for a deposit 0.00018 inch thick. The work is then removed and rinsed in cold and hot water.

The bath is operated at 170-175 deg. F. With use, the free alkali content of the bath increases and if too high causes semimicroscopic blisters. The free alkali content must be kept below 0.3 oz. per gal. by addition of acetic acid.

A sludge, worth 2-5 cents per lb., gradually collects in the bottom of the tank.

A schedule of sodium stannate and acetic acid additions can be worked out according to production, *e.g.*, 10 lbs. sodium stannate for each 1000 pistons and one gal. of acetic acid for each 2000 pistons. In heavy production, the solution should be analyzed daily.

—Edward Finnis, *Products Finishing*, Vol. 6, Mar. 1942, pp. 42-44.

Gas Furnaces in War Production

Condensed from an American Gas Association Paper

Current achievements in the production and quality of our munitions and armament would not be possible if engineering ingenuity and energy had not been utilized during the past 24 peacetime years in the development of better *peacetime* products.

Shell Nosing

A good example of this is the rotary gas furnace, designed during World War I

There is no better proof

of a Product's Performance than the REPEAT ORDERS it Earns!

A Few of the Firms That Have Re-Ordered Maehler Ovens and Furnaces

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AND THERE ARE MANY MORE — THE LIST IS A LONG ONE!

• The bulk of all Maehler Ovens and Furnaces being built today must go to fill a long list of *repeat orders* from customers engaged in War's forced draft production. There is no more conclusive evidence of the superior performance of Maehler equipment than this re-order endorsement from among the leaders of industry, and there is no better guide to your *future* purchases of this type of equipment.

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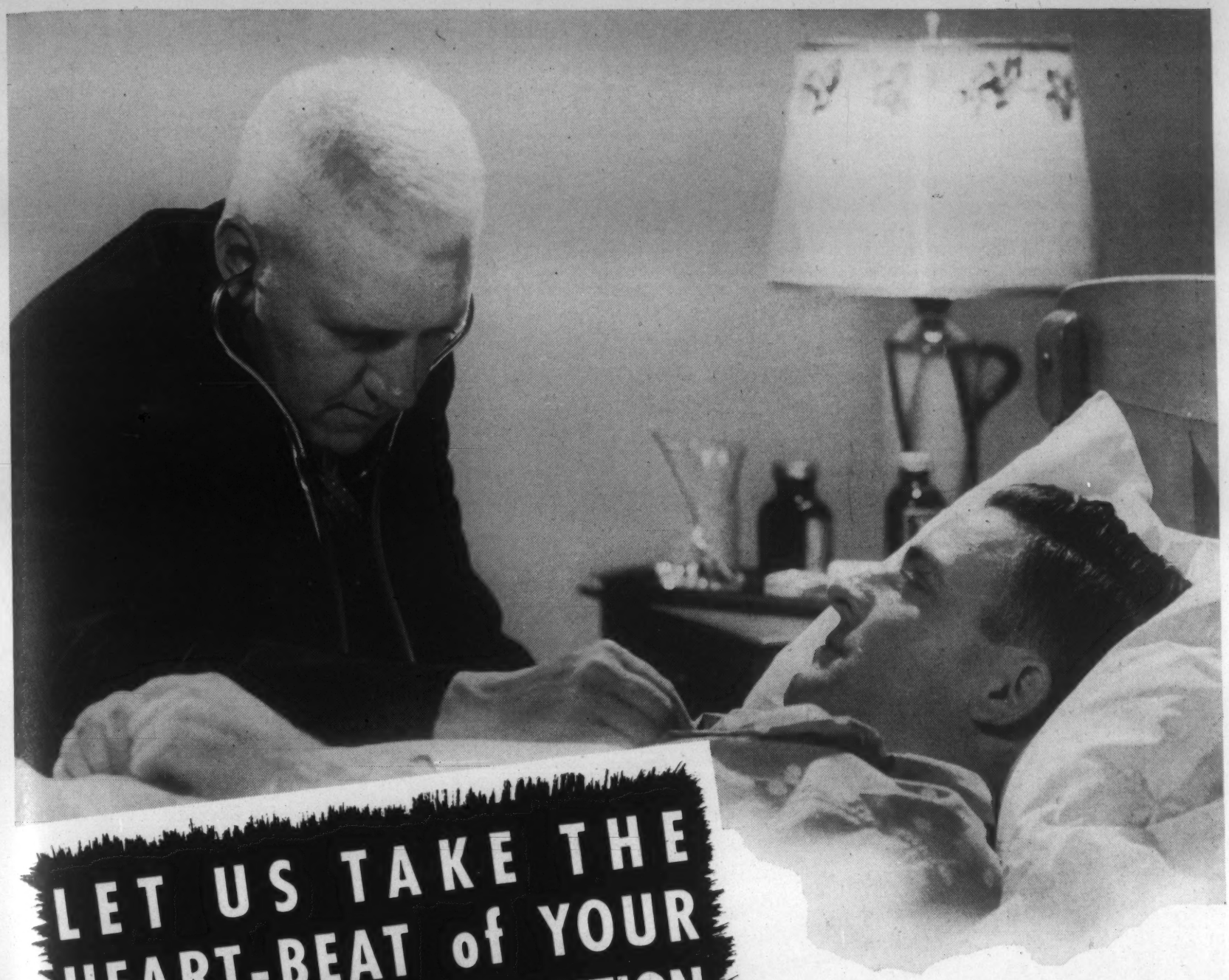

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Today, many manufacturers are faced with the problem of processing items for defense with which they are unfamiliar. Our national emergency demands that these new products be turned out on split minute schedules — speeded up to meet this national need. Many new metals will have to be used that demand new treatment and finishing and cleaning prior to finishing.

The MacDermid Chemical Corporation has specialized for over twenty years in perfecting chemicals and compounds to meet every need for metallurgically and chemically cleaning all types of basis metals. This specialization is particularly important to you at this time and MacDermid sales engineers, located from coast to coast, will be more than willing to show you through actual demonstration where and how MacDermid chemicals and compounds will improve, speed up, and reduce your manufacturing costs by saving time, money, labor and valuable metal needed for defense.

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for shell nosing. After the forging operation, the next step in making shells is the tapering of one end to reduce air resistance and increase its penetrating power. It is true that some projectiles are nosed cold, but all the larger projectiles are tapered under high heat. For these latter, a temperature of about 1850 deg. F. is necessary for forming.

The rotary furnace, developed during World War No. 1, has many advantages, particularly because this type of furnace insured a definite time temperature cycle. The only disadvantage in the older, original furnace was the scaling, of the shell, which was injurious to the dies and sometimes became worked into the projectiles themselves during the forming operation. Now, however, with a furnace of the same design equipped with the more recently developed gas variable-flame burner, firing directly and vertically, down into the furnace, this objection is completely overcome.

As a further example of just what gas heat treating means to projectile manufacturers, the following figures will be interesting. During World War No. 1, the cost of a 155 mm. shell was somewhere in the neighborhood of $45, and today the same shell, of better quality and produced in much greater numbers, is being made for less than 50 per cent of the old original cost.

Annealing Cartridge Cases

Another example is the manufacture of cartridge cases. In the almost forgotten peace days, one of the earliest studies sponsored by the A. G. A. Committee on Industrial Gas Research dealt with the clean annealing of brass. At the time, only a limited application found its way into the manufacture of commodities.

Now, however, this peace-time industrial gas research is bearing fruit. Cartridge cases require 3, 4 or even 5 drawing operations depending on the process and the size. These operations, of course, harden the brass and, as a consequence, after each draw an annealing or softening process at temperatures ranging from 1200-1250 deg. F. is used to prevent cracking of the metal in the subsequent draw. It thus became necessary to apply the knowledge gained in the early research on clean annealing of brass to the present day manufacture of cartridge cases, and for this purpose, the convection type furnace was found to give a faster rate of heating, a better temperature uniformity and greater economy than the older, direct-fired furnaces. The finished product is clean, smooth, and will fit into the gun breeches with exactness and precision.

—J. M. Heyn, *American Gas Assoc.*, Industrial and Commercial Gas Conference, Mar. 1942. 4 mimeographed pages.

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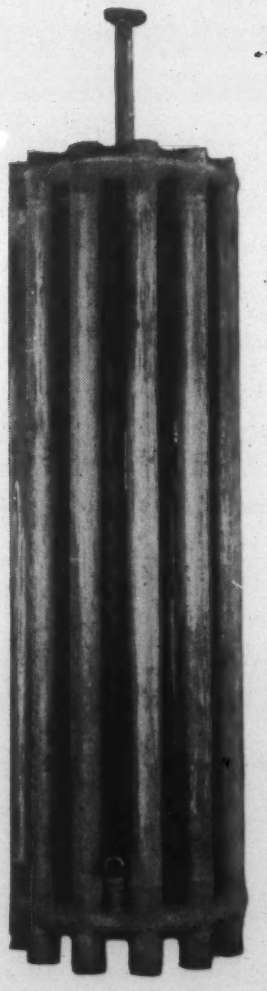
High Alloy Casting SERVICE



. . . meeting today's problem of heat, corrosion and abrasion by skillful use of available alloying elements. Industrial equipment need not suffer from heat, corrosion or abrasion in its greatly stepped-up production program. There is still an imposing battery of alloying elements available and by proper selection and use of these, and by proper heat treatment, castings can be given desirable characteristics.

Duraloy Metallurgists, long skilled in this important work, will be glad to help work out your casting problem and then turn out these castings for you.

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6-DU-2

Heavy Nickel Plating

Condensed from "Monthly Review," Am. Electroplaters' Society

Heavy nickel deposits are plated for two reasons, (1) to give adequate protection against corrosion and wear, (2) to supply an increase in dimension.

Many types of nickel solution were investigated for suitability for making heavy deposits, a modification of the Watt's formula being finally selected. Baths operated within the following limits gave good plate quality:

Single nickel salts	.29 to 40 oz. per gal.
Nickel chloride	....2 to 16 oz. per gal.
Nickel	.....7.5 to 11 oz. per gal.
Boric acid	.....2 to 8 oz. per gal.

Operating conditions were: temperature, 120 deg. F.; current density, 32.4 amp. per sq. ft.; pH, approximately 5.2.

Other solutions reported by others but listed by the author, are: (1) for extremely high deposition rates, the above solution operated at a pH of 1.5 to 2 (such baths have comparatively poor throwing power); (2) for high current densities, the nickel chloride-boric acid bath described by Wesley and Carey. (*Trans. Electrochem. Soc.*, Vol. 75, 1939, 209-36.) This bath gives moderately hard deposits; (3) Watt's type bath operated in the pH range of 3 to 4.5. Although some authors have claimed increased deposit smoothness from the latter bath, these claims are not found to be entirely justified.

It is important for good results with heavy plating to keep the solution rigidly clean, both chemically and physically.

Successful heavy plating starts with the design of the work. Work should be designed with adequate clearances, proper undersizing, and filleting of sharp corners. If necessary, fillets may be formed by

IMPROVED HEAT TREATING • *Increased Production* • *Decreased Rejection* • *Better Physical Properties of Carbon Steel*

PATENTED

Precise control of quenching temperatures, with quenching water in closed system to avoid contamination by iron or acids has helped steel treaters to increase production with decreased spoilage losses. This is especially valuable with induction hardening methods and with oil quenching baths.

It is done by a new method, applying the principle of evaporative cooling, with the NIAGARA AERO HEAT EXCHANGER, with savings in equipment cost because no cooling tower is needed, and in operating cost because 95% of cooling water is saved, as well as power and space.

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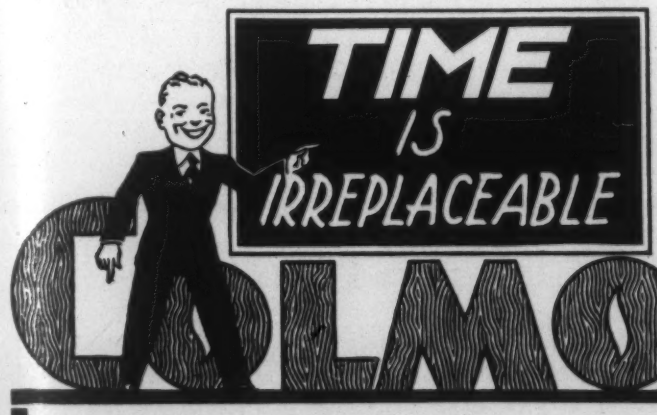

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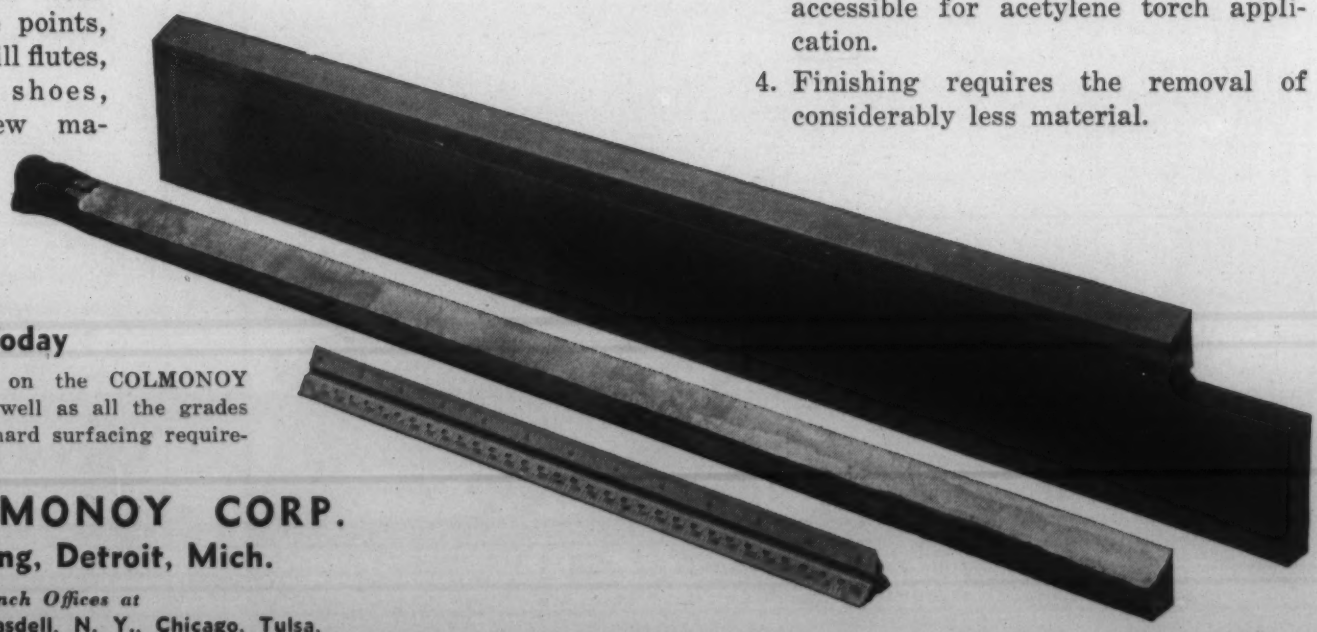
COLMONOY FURNACE WELDING

This process consists of applying a casting of COLMONOY No. 6 hard-surfacing alloy to steel base parts that are subject to corrosion, abrasion, wear and galling. Some of the advantages of this process are:

SAVES VALUABLE TIME

1. It is adaptable to high production parts.
2. There is complete freedom from porosity and cracks.
3. Parts can be hard-faced which are inaccessible for acetylene torch application.
4. Finishing requires the removal of considerably less material.

Use COLMONOY No. 6 on parts subject to great wear and abrasion — lathe points, dogs, chip breakers, drill flutes, wire straightening shoes, thrust bearings, screw machine fingers, forming and drawing edges, etc.



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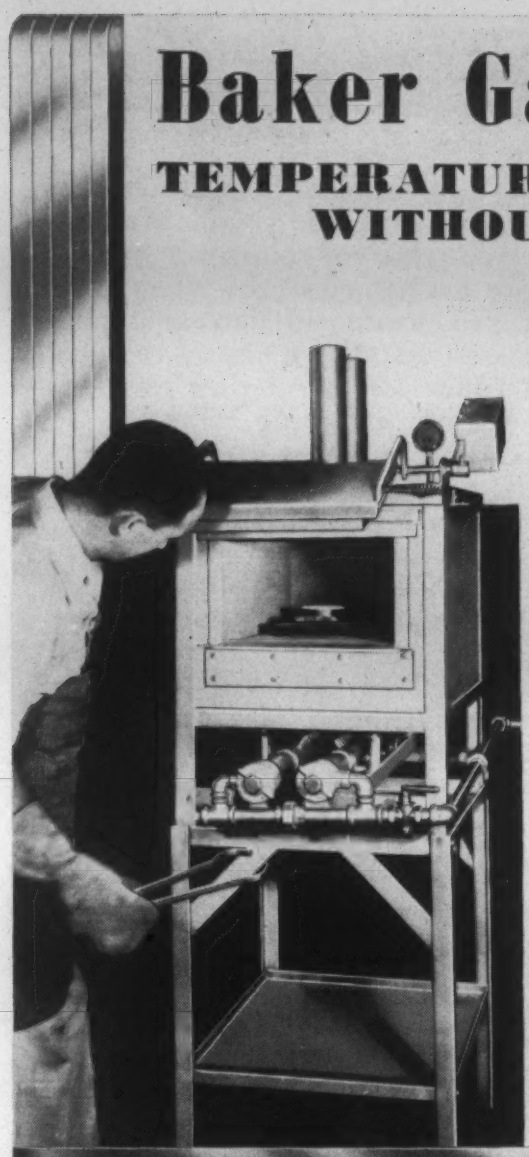

BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6″ x 8″ x 5½″, to No. 24, which is 12″ x 20″ x 8″ as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6″ x 12″ x 5″, is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½″ x 15″ x 2½″ high.

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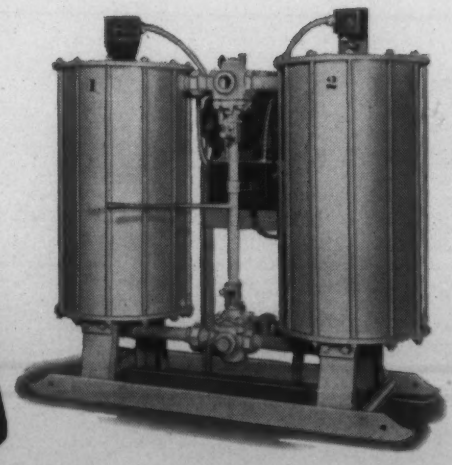

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brazing, welding, or soldering. In plating undersized parts a 100% overplate should be deposited, but in the interests of conservation, 50% overplates are being attempted.

The surface finish is not critical. Usually the finish delivered by the machine shop is satisfactory, but all surface defects which might not cover must be either ground out, plugged out, or burnished in. Pickling is sometimes necessary, but overpickling should be avoided, and pickling inhibitors should be used.

The cleaning procedure preferred for iron and steel parts is: (1) either anodic or cathodic electrocleaning; (2) scrubbing with slaked lime or a mixture of slaked lime and pumice; (3) water rinse and wipe; (4) flash pickle in hot dilute sulphuric acid or cold 1.3 muriatic acid; (5) rinse; (6) nickel plate.

Heavy nickel plating of irregular objects is similar to chromium plating with regard to the careful anode arrangements required. Interior anodes should be connected through separate rheostats and ammeters. The position of the objects being plated should be periodically shifted. It is necessary to intermittently dislodge gas bubbles from the under surfaces by use of squeegees, rubber gloves, etc.

The work must be frequently sized during plating. Work must not be kept out of the tank for this purpose longer than 30 to 40 secs. If more time is required, the work must be dried, gaged, then cleaned with lime, acid rinsed, struck in a nickel chloride strike and then replaced in the plating solution.

—W. M. Tucker,
Mo. Review, Am. Electroplaters' Soc.,
Vol. 29, Mar. 1942, pp. 196-210.

STARTING THIS MONTH

on p. 907

"THE PRODUCTION FRONT"

A New Department written by Harold A. Knight

WAR-PRODUCTION NEWS, TRENDS, FORECASTS

Get the facts

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Despatch Pot Type Furnaces (below) are ideal for experimental work for pilot lines or small production lines

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Continuous Conveyor Furnaces are available for heavy production.

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Steel and Wood Aircraft

Condensed from "Aero Digest"

Use of ordinary low-carbon, low-alloy steel ("mild alloy steel") and of plywood in combination as a substitute for the conventional aluminum design has been developed by North American Aviation engineers for the construction of AT-6A combat trainers. Although this is not expected immediately to make any tremendous dent in the general use of aluminum and its alloys in aircraft, the steel-and-wood design may play a crucial part in the present war if it develops into a resource-draining battle of production.

It is said that nothing has been sacrificed in quality or performance in accomplishing this reduction in aluminum as an aircraft necessity. The mild alloy steel used has been strengthened for aircraft structures by cold reduction. It contains less than 2 per cent of strategic alloys, as contrasted with more than 25 per cent in stainless steel.

On North American's trainers, the use of plywood and steel will eliminate 75 per cent by weight of aluminum alloy. Thus, for each thousand of these 4,000-lb. trainer planes, enough aluminum will be saved to build 420 pursuit planes or 150 medium bombers.

Except for a smoother surface on wings and fuselage, the new planes will look much the same as their predecessors. The exterior surface of steel wings will be as smooth, because rivet heads will be eliminated, the sections being joined by the spotwelding process. The wood assemblies, on the other hand, will be joined by glue.

The importance of spotwelding to replace riveting in high-speed assembly cannot be overestimated. Some 35,000 rivets go into a typical pursuit plane, 150,000 into the average bomber. The AT-6A trainer uses 52,336 rivets of various sizes and shapes.

Spotwelding, on the other hand, can be done by one operator at the rate of 350-1,000 spots per min. Low carbon, low alloy steel is an excellent material for spotwelding, and the strength of the spotwelded joints on a steel assembly is considerably greater than that of a rivetted joint.

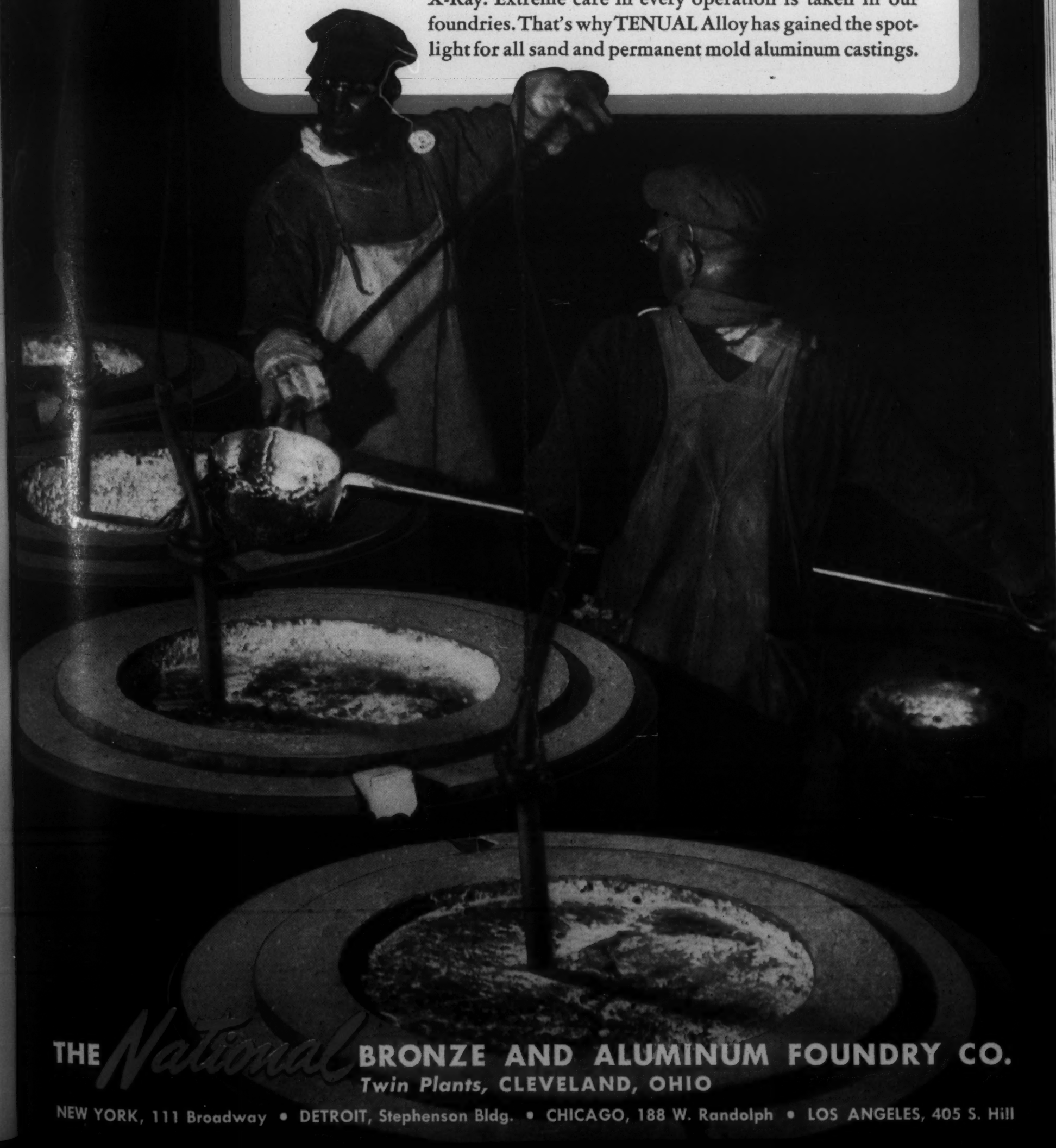
One disadvantage encountered with the new materials is a slight decrease in the strength/weight ratio. Until research catches up with the airplane designers, the trainers will probably be about 150 lbs. heavier than the original all-aluminum AT-6A, but that weight increase is safely allowable in view of the plane's permissible design overload of 350 lbs.

A structure manufactured from the steel now being used would weigh approximately 12 per cent more than an equally-strong structure manufactured from aluminum alloy since the steel weighs 2.83 times as much as aluminum alloy. Another point is that the mild alloy steel can be manufactured inexpensively with existing steel production facilities.

Furthermore, aluminum alloy used in aircraft construction, being subject to corrosion, is generally coated with a thin

TENUAL

Melting is one of the most frequently overlooked practices in foundry business. To insure that our customers secure only the highest quality aluminum castings, so necessary for our armed forces, the melting and pouring of all TENUAL Aluminum Alloy is under automatic temperature controlled pyrometers along with the expert supervision of our experienced metallurgists. ● This close control prevents overheating which is so detrimental to physical properties. Chemical analyses and physical tests are taken from each heat of castings poured. In addition, we have complete X-Ray equipment to take care of all castings requiring X-Ray. Extreme care in every operation is taken in our foundries. That's why TENUAL Alloy has gained the spotlight for all sand and permanent mold aluminum castings.



THE *National* BRONZE AND ALUMINUM FOUNDRY CO.

Twin Plants, CLEVELAND, OHIO

NEW YORK, 111 Broadway • DETROIT, Stephenson Bldg. • CHICAGO, 188 W. Randolph • LOS ANGELES, 405 S. Hill

Automatic Pressure Testing machine.
Courtesy: Continental Can Company

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of your soldering problems!

During this critical shortage of tin, Federated low-tin and tin-free solders are doing yeoman service in meeting today's soldering requirements.

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"S.T." SOLDERS are available in all commercial forms, including acid and rosin core wire. For details on the complete range and properties of these solders, or for technical assistance on a specific problem, contact our nearest office.

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Always specify FEDERATED ALLOYS

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(*Chicago Dist.*)

veneer of pure aluminum, and must be handled carefully to avoid scratches. Steel, on the other hand, can be treated almost carelessly in the manufacturing process, without damage.

Even bonderizing may be eliminated before steel aircraft assemblies really get into mass production, due to the development of a new protective compound which can be sprayed on the sheet steel as soon as it arrives from the mill—a compound which permits spotwelding after it has been applied.

Also, the use of steel exterior surfaces may eventually eliminate some of the heavy armor plate used in combat craft, since bullets will glance off more readily from a curved steel surface, with its high penetration-resistant qualities, than from a thicker, curved aluminum alloy surface of the same unit weight.

Steel sheets as used by North American vary in thickness down to a minimum of 0.01 in. This minimum thickness is determined partially by other factors, such as cost of manufacture and workability. In like manner, modern aircraft design practice holds the minimum thickness of aluminum alloy sheets to 0.025 in.

The type of structure used with steel is essentially the same as the normal aluminum alloy structure—a stressed external skin, reinforced by transverse internal ribs and bulkheads and by longitudinal internal stringers.

Not only is the same basic structural design possible with steel as with aluminum alloy, but the same fabricating and forming methods can be used. The Masonite dies and rubber blocks used in aircraft hydraulic presses, and the zinc and lead dies used in drop hammers for fabricating aluminum can be applied equally well to steel sheets.

Although wooden structural parts are a farther departure from conventional aluminum alloy than steel, North American has found that the same basic structural designs can be used with wood as with metal.

—*Aero Digest*, Vol. 40, May 1942, pp. 127-128, 130, 272-274.

Metal-Design of Tube-Fittings

Condensed from "Machine Design"

In selecting and designing fittings for tubing or piping as installed in increasing quantity in today's machines, pressures and the extent of vibration encountered are usually the controlling considerations. Ease of assembly and maintenance in the field are second only to the need for a dependable joint. Breakdown of a fitting, though seemingly unimportant, can be just as disastrous as that of any other mechanical part.

With respect to pressure problems, many fittings are designed to withstand the bursting pressure of the tubing to which they are applied. Vibration, however, is not so simple a matter and care should be exercised in both the selection of fitting and method of application to minimize vibration stresses, if present.

Probably the simplest and one of the oldest fittings is the familiar compression type for brass and steel tubing. The joint consists of a sleeve or ferrule, a nut and

ZINC IN WAR

PROTECTING THE MERCHANT MARINE

The United States must not only out-produce our enemies, we must see to it that this matériel reaches the far flung fighting fronts. To this end America has dedicated itself to the most gigantic ship building program in all history—and these vessels must be made as efficient as humanly possible for the courageous men who sail them.

Zinc plays an important role in protecting metal surfaces, and thus protecting men at sea. Working metal parts on ships can easily be fouled by rust. To insure efficient operation when emergencies demand quick action, such important parts as life-boat davits, shown above, are sprayed with protective zinc coatings. The corrosion-inhibiting properties of galvanized (zinc coated) iron or steel are well known —and sprayed zinc dust provides this same measure of protection for metal surfaces which do not lend themselves to galvanizing.

The photographs in the background of this advertisement show: (1)—left to right—Cast iron sheaves for life-boat davits before finishing, after grit blasting and after spraying. (2) Stacks of completely finished sheaves. (3) Grit blasting the sheaves and (4) Spraying them with zinc dust using a special gun.

Other important uses for sprayed zinc include marine floats, airplane pontoons and canal gates. The needs of the Navy and Merchant Marine for sprayed zinc coatings are just additional reasons why civilian users of zinc may not be able to obtain all of the metal or pigment they would like to use.

THE NEW JERSEY ZINC COMPANY

MANUFACTURERS OF THE FAMOUS HORSE HEAD ZINC PRODUCTS

1 8 METAL SPRAYING
GALVAN-IZING
NICKEL SILVER
1 HULL PLATES
2 RUBBER
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4 BRASS
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FOR VICTORY
BUY UNITED STATES WAR SAVINGS BOND STAMPS

600 FORGEABLE BEARING ALLOY

Contains No Tin!

★ GEAR BLANKS ★

★ SPINDLES ★ SEAL RINGS ★

★ GEARS ★

★ BUSHINGS ★

★ BEARING RINGS ★ WORM GEARS ★

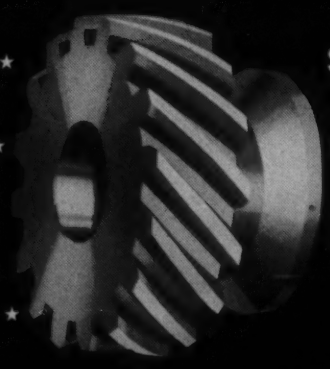
★ CONNECTING RODS ★

★ CAMS ★

★ DRAWN RODS ★

★ THRUST WASHERS ★ EXTRUDED

★ CAMS ★ SHAPES ★



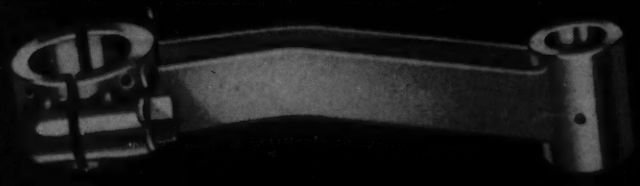
★ GEARS ★ ★ BEARING

★ SEAL RINGS ★

RINGS ★ ★ DRIVE

★ PROPELLER SHAFTS ★ SHAFTS ★

★ SUPERCHARGER SHAFTS ★ CAMS ★



★ DRAWN RODS ★ EXTRUDED SHAPES ★

★★ yet HAS SUPERLATIVE BEARING PROPERTIES

● "600" has been successfully used for over 14 years as the solution to many extremely difficult bearing problems. It is a true bearing metal and—an entirely different one. It has a structure made up of two types of crystals—soft and hard. The hard crystals are elastically and uniformly embedded in a matrix of soft crystals. The hard crystals absorb the pressure in the bearing, diminish the friction, and cause a better distribution of lubricating oil between bearing surfaces.

Many thousands of auto and truck transmissions have their reverse idler gears running on shafts of "600." A large quantity of it has been very successfully used for pump rods and other purposes where lubrication may be neglected. It is ideal for propellor shafts in power boats—and literally hundreds of other tough applications.

The corrosion resisting properties of "600" are particularly valuable. "600" forgings are being increasingly used for bulkhead door latches and fittings on naval vessels where strength and resistance to abrasion and corrosion are of paramount importance.

Here's What on Electric Switch Manufacturer Says:

"The ⅞" diameter "600" rod is used to make bushings for clapper switches, the life of which is approximately twenty million operations. The bushing is used in the pin hole of the lever which is attached to the base by means of a pivot pin. When closing the circuit these switches are subject to a terrific jolt, and we are obtaining especially good results since using Mueller Brass Co. "600" bearing material. This material is also used on smaller switches where, instead of severe jolts, there is a sliding action both on the outside and the inside of a plunger. This plunger works up and down on a pin while the outside must slide in and out of a bracket with very little clearance."

"600" BEARING ALLOY CONTAINS NO TIN YET HAS SUPERLATIVE BEARING PROPERTIES—AN ADDED REASON FOR ITS ADOPTION AND INCREASED USE AT THIS CRITICAL PERIOD.

Write us if you have a bearing problem or for additional information.

MUELLER BRASS CO.
PORT HURON, MICHIGAN

a body member. With the nut and ferrule over the tubing and the tubing inserted in the body, tightening of the nut compresses the sleeve between the tubing and fitting, giving a tight joint suitable for operation at moderate pressures.

In use in Europe throughout the past 8 yrs. and domestically for 3 yrs. is a high-strength compression fitting known as the Ermeto fitting. The ring or ferrule is machined so that it has a sharp leading edge. When the nut is tightened the ring slides forward and, because it has this sharp edge, cuts its own seat on the tube.

Rings for various kinds of tubing are made of a material that is always harder than the tube itself. On copper tubing, a copper-plated steel ring is used. For steel tubing, a steel ring with a shallow cyanide case is employed.

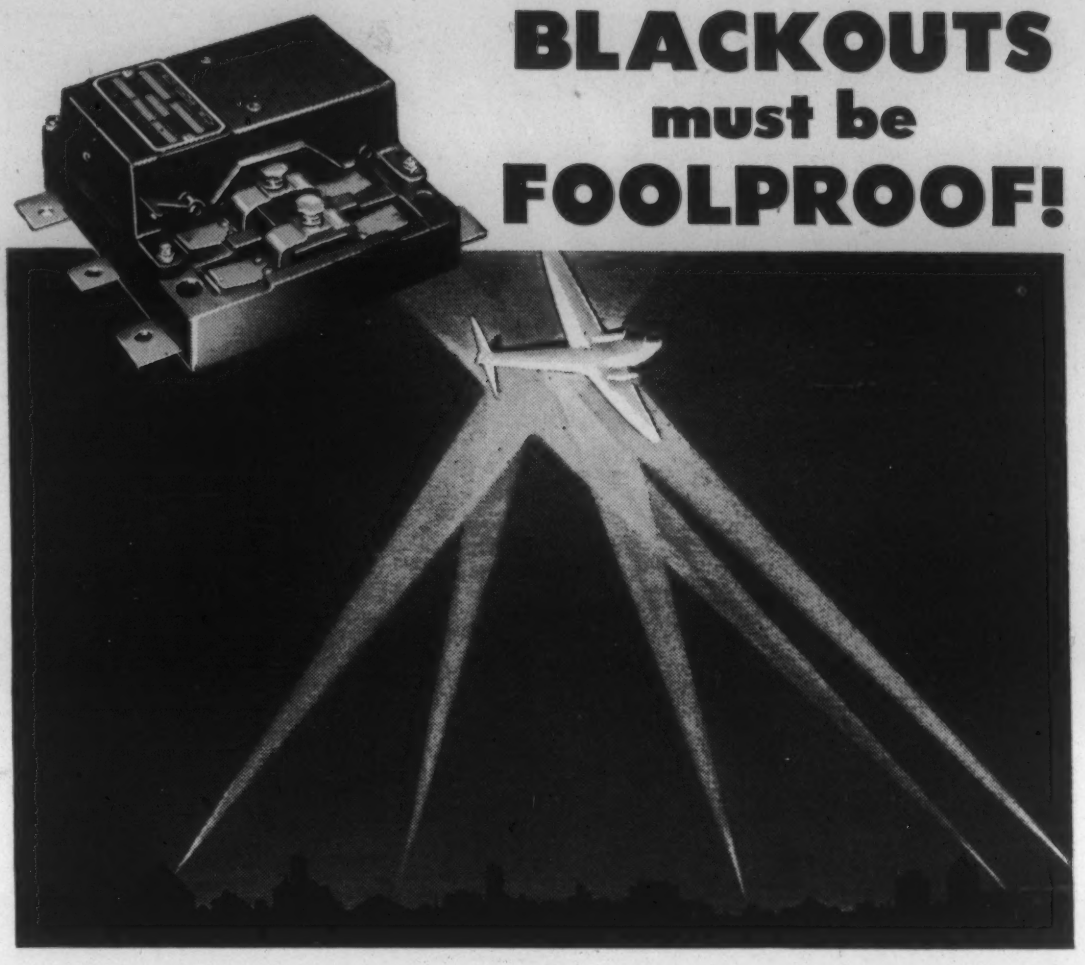
To strengthen the joint against vibration and obviate possible failure where the edge of the ferrule cuts a ring on the tubing, the end of the ferrule has a smooth bore which is clamped tightly on the tube by the angular face of the nut after the cutting edge of the ferrule has formed its seat. Vibration on a properly fitted joint should not reach beyond the clamped portion for maximum strength. In all joints involving metal ferrules, the ferrule becomes a part of the tubing. The joint may be assembled a great number of times but, if the tube is replaced, a new ferrule is required. From the point of view of resistance to vibration, any scratch or marking on the tubing to which movement could reach, might result in fatigue failure.

Extended nuts have been applied to add support to the joint. Again, commercial tolerances could easily involve sufficient clearance to cause high stress concentrations in the joint and extended nuts should therefore be applied with care.

Design of tubing layout may often obviate excessive strain on the joint. Developed to overcome a weakness of the S.A.E. fitting, a design more resistant to fatigue and less affected by reassembly is the sleeve-type flared fitting. A metal collar with a 45-degree matching face holds the flared tubing against the body seat by the tightening action of the nut on a square shoulder.

In this way the tube itself receives no wiping action from the nut and the possibility of the tube becoming weakened by scoring or excessive working is therefore eliminated. This type of fitting is now being used widely for aircraft applications where the bodies of the fittings are either anodized aluminum alloy or nickel steel.

One design using a neoprene sleeve has a strength sufficient to develop the full bursting strength of a 52-S aluminum alloy tubing conforming to Army-Navy standards. In this joint, tubing is flared at an angle of 12 degrees with a small locking ring assembled immediately behind the flare. The resilient sleeve has metal bushings at each end to confine the synthetic rubber. Under tightening of the nut, the compression sleeve conforms to the outer wall of the tube and the angular faces of the body and nut.



BLACKOUTS must be FOOLPROOF!

Blackout Control Switch Springs of

CALLITE *BERYLLIUM COPPER* WIRE

▶ Few peacetime highway and plant lighting methods are adequate under war conditions. Remote controls require infallible, automatic control switches. In the simple, powerful, split-second control mechanism pictured above, made by the *Automatic Switch Co.*, constant high contact pressure is maintained and positive operation assured by the use of specially heat-treated beryllium copper springs. These springs, supplied by *Instrument Specialties Co.*, are formed of Callite beryllium copper wire.

▶ Callite's high standards guarantee dependable uniformity in structure, temper, size and forming reaction. Our technicians will gladly recommend the most suitable composition for your specific requirements. Callite Tungsten Corporation, 546 — 39th Street, Union City, N. J. Branches: Chicago, Cleveland.

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ALUMINUM	COMMERCIAL BRONZE	SILICON BRONZE
BERYLLIUM COPPER	EVERDUR	SILVER
BRASS — ALL GRADES	NICKEL-SILVER	SPECIAL ALLOYS
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CALLITE TUNGSTEN CORPORATION CT

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New Frasse Chart Combines 3 Standard Steel "Specs"

This new time-saving data chart combines steel specification standards of both the American Iron and Steel Institute and Society of Automotive Engineers—also includes similar Aeronautical Material Specification (AMS) numbers. This effort-saving arrangement shows complete chemical composition for each "spec"—lists AISI and SAE numbers for both 1942 and 1941 to simplify identification.

Latest in a series of useful Frasse charts, it is printed on tough card stock, standard file size. Can be filed, tacked on wall, or slipped under glass to keep it handy. For a copy, without charge, send the coupon today to *Peter A. Frasse and Co., Inc., 17 Grand St., N. Y. C. (Walker 5-2200). 3911 Wissahickon Avenue, Philadelphia (Radcliff 7100—Park 5541). 50 Exchange St., Buffalo (Washington 2000). Jersey City, Hartford, Rochester, Syracuse, Baltimore.*

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STAINLESS STEELS · COLD ROLLED STRIP AND SHEETS · WELDED STEEL TUBING

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Grand Street at 6th Avenue, N. Y. C.

Please send me, without obligation, a copy of your steel specification chart, Section F, Number 1.

NAME_____ FIRM_____

ADDRESS_____

When major movements are required of the tubing or vibration is of large amplitude, the action is too severe for semi-rigid tubing such as brass or Bundy steel tubing. Flexible tubing then is needed. Rubber, fabric-covered neoprene, Hicar or other synthetic hose may be used. Some types have steel wire wound under the fabric cover to provide protection against kinking.

—John W. Greve, *Machine Design*, Vol. 14, May 1942, pp. 58-60, 142, 144.

Fatigue Strength Design Calculations

—The Effect of Range of Stress

Condensed from "Univ. Illinois Eng. Exp. Sta. Bulletin"

This publication includes the most extensive collection of data on the effect of range of stress on fatigue strength which the reviewer has seen. The author of the bulletin has made a number of tests himself and has made a careful study of the literature both American and foreign.

Some Engineering Definitions

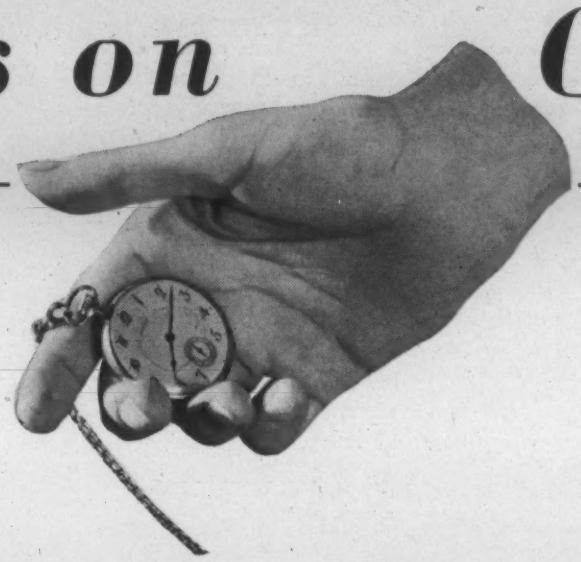
In defining range of stress at least three methods have been in use. They can best be defined by an illustration. Let us suppose that during a cycle, the stress ranges from 10,000 lb. per sq. in. tension to 5,000 lb. per sq. in. compression. The range may be defined completely by saying (1) that the maximum stress is 10,000 lb. per sq. in. tension and the range of stress is 15,000 lb. per sq. in. or (2) it may be stated that the maximum stress is 10,000 lb. per sq. in. tension and the ratio of minimum to maximum (numerical) stress is $-\frac{1}{2}$, or (3) it may be stated that the cycle of stress is equivalent to a steady tensile stress of 2,500 lb. per sq. in. with an alternating stress superimposed with a range of $\pm$ 7,500 lb. per sq. in.

It is the third method which Mr. Smith used in his bulletin. He also finds it convenient to redefine endurance limit, defining it *not* as the maximum stress for any given cycle below which failure will not occur after an indefinite number of cycles, but as the range of alternating stress ($\pm$ 7,500 lb. per sq. in. in the example given above) under which, combined with a given mean stress, the metal will not fail after an indefinitely large number of cycles. [*It is necessary to keep this definition very definitely in mind while reading this bulletin. Perhaps "fatigue range," or "endurance range," would have been a little more suitable term than the redefined "endurance limit"*—H. F. M.]

In the bulletin two types of diagram are used for the graphical presentation of results. One diagram is called the steady-stress alternating stress diagram in which the steady stress component is plotted as abscissas in terms of proportional part of the ultimate tensile strength, and the alternating stress component ["endurance limit" as Mr. Smith calls it] is plotted in proportional part of endurance limit for cycles of completely reversed stress.

The other diagram, which he has found especially useful for cycles of stress in which the maximum stress is compression, is a diagram plotted with maximum stress

Hands on Our Time



SUPERIOR small tubing is known the country over for its assured metallurgical characteristics, bright finish, and consistent physical properties. There has not been, and shall not be, any deviation from these high standards in spite of increased demands for Superior seamless and weldrawn tubing.

Our time is not our own—it's in the hands of our armed forces and the hundreds of users of Superior tubing for Defense production—who are depending upon us to produce a high quality product in increasingly large quantities.

To a man, our organization is fighting hard, and we're using every minute of every day to produce for offense. Small tubing is our only business, and we know it!

An announcement to the users of preference-rated small tubing:—

Superior produces cold drawn seamless and weldrawn tubing up to 5/8" OD in many metals, as well as seamless and patented lockseam cathode sleeves. Do not hesitate to contact us for new or conventional types or uses for small metal tubing.

SUPERIOR

THE BIG NAME IN
SMALL TUBING

SUPERIOR TUBE COMPANY, NORRISTOWN, PENNSYLVANIA

Tubing from 5/8" OD down... SUPERIOR Seamless in various analyses. WELDRAWN Welded and drawn Stainless.

BRAWN Welded and drawn "Monel" and "Inconel". SEAMLESS and Patented LOCKSEAM Cathode Sleeves.

in the range as abscissas (expressed as proportionate part of static compressive strength), and proportionate parts of the endurance limit under cycles of completely reversed stress as ordinates.

Notch Effects

Mr. Smith has made studies of test data on ductile and brittle materials, on specimens notch-free and on notched specimens. He has made studies of data for specimens under shearing stress and under tension-compression, finding that under repeated shearing stress a notched specimen usually develops a tensile failure, while with notch-free torsion specimens of ductile metal fatigue failure frequently starts in a shear crack. One of the most interesting facts that he has brought out is that the stress raising effect of a notch in a specimen applies only to the alternating component of stress in any range of repeated stress in which the steady stress is tension. Hence, in the design of a member having a stress raiser to resist cycles of repeated stress in which the steady stress is tension, the stress-concentration factor, K, is used in the formulas when calculating the alternating stress, but it is not used when calculating the steady stress.

He, therefore, concludes that the steady stress acts in damaging the member more as a static stress, while the alternating component of the range is associated with the formation and spread of a progressive (fatigue) fracture.

Working Stresses for Design

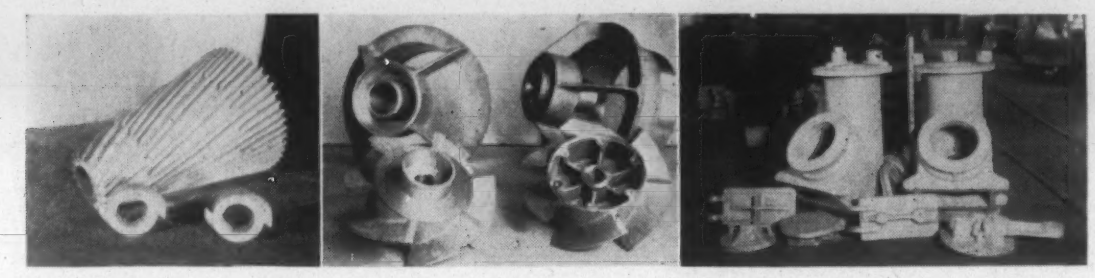
In selecting working stress for the design of a structural or machine part made of ductile material to resist repeated stress it should be recognized that either of two types of failure may occur, (1) general yielding on the first application of the load, or (2) progressive fracture after many repetitions of the load.

A graphical method for determining working stresses which are based on the possibility of these two types of failure is given in the bulletin.

The three physical properties which are needed in applying the method are as follows: the static yield point (or yield strength); the static ultimate tensile strength; and the endurance limit under completely reversed cycles of stress. The use of this method of determining working stresses is illustrated in the bulletin by applying it in the design of a structural part containing a stress raiser.

The illustration shows the importance of considering the steady and alternating stresses as separate components of the range when they are calculated for a member in which a stress raiser is present.

— J. C. Smith,
Univ. Illinois Eng. Exp. Sta. Bull.,
Series No. 334, 49 pp.



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DAYTON, OHIO

TECHNICAL DATA SHEET

Durco KA2S is the most important of the "18/8" chrome-nickel group of austenitic alloy steels. It has a maximum carbon content of 0.07%. Because of its excellent corrosion-resisting and mechanical properties, the applications for it are many and varied. Durco KA2 and Durco KA2H are other members of the "18/8" group containing higher carbon content.

COMPOSITION

Chromium	18.00-20.00%
Nickel	8.00-10.00%
Carbon	0.07% max.

PHYSICAL CHARACTERISTICS

Specific Gravity	7.80
Weight, lbs. cu. in.	0.281
Specific Heat, Cal. per deg. C.	0.12
Casting Shrinkage, per ft.	¼"-5/16"
Electrical Resistivity, Microhms per Cm^3	73
Melting Point, deg. F.	2650
Thermal Conductivity (C.G.S.)	0.05
Coefficient of Expansion (32-212 deg. F.)	0.000009

MECHANICAL PROPERTIES

Ultimate Strength, p.s.i.	80-90,000
Yield Point, p.s.i.	30-40,000
Elongation, % in 2"	40-55
Reduction of Area, %	40-55
Hardness, Brinell	130-150
Izod Impact, ft. lbs.	95-97

Machinability, 50-75% compared to cast steel.
Welding Properties, very good.

PRODUCTS AVAILABLE Pumps, valves, fittings and special castings.

RESISTANCE Very good to Acetic, Boric, Citric and Nitric Acids; Calcium, Copper and Sodium Sulphates; Ammonium and Zinc Chlorides; Liquid Condiments, Fruit Juices, etc.

APPLICATION Widely used for chemical, food and textile industries, and in manufacture of explosives.

THE DURIRON COMPANY INC. DAYTON OHIO
DURIRON · DURICHLOR · CORROSION-RESISTING DURCO ALLOYS & EQUIPMENT THE DURIRON CO. INC. DAYTON OHIO · DURIMET · DURCO STAINLESS STEELS

Design of Cast Crankshafts

Condensed from "Foundry Trade Journal"

To expect a cast shaft to follow rigidly the design of a forged steel crankshaft is obviously unsound practice. Such things as balance weights, fillets and web shapes can often be modified with advantage to suit foundry requirements.

The main reasons for unsatisfactory performances in a crankshaft are fatigue failure, poor wear values, inability to withstand shock, etc. A casual post-mortem on a crankshaft might indicate that its failure was due to fatigue, but possibly fatigue is only the ultimate breakdown manifestation, the basic cause being something more deep-seated. Heavy wear on the bearings and journals due to slight misalignment of the shaft, for example, might have set up such high operational stresses that the "fatigue failure" developed as a secondary cause.

Advantages of Castings

Shafts may easily be lightened by coring out, and this eliminates unnecessary weight; less material is used for the same size crankshaft when cast as compared with a forging. A casting also has better wear resistance, high fatigue and damping properties combined with rigidity, and reduced resonance and gives smoother running. These factors are leading to the rapid adoption of cast iron for this purpose.

Expensive dies, forging presses and heat-treating plants are not necessary for castings. Not only can a cast iron crankshaft be machined more quickly than high alloy or normal steels, but a considerable saving in material is made.

It has been generally established that

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offers laboratory facilities to help you solve "WHAT MATERIAL?" problems . . . C-D manufactures five distinct types of NON-metallic materials . . . DILECTO laminated plastics . . . CELORON molded fabric plastics . . . DIAMOND vulcanized fibre . . . MICABOND mica products and VULCOID laminated resinous fibre. C-D provides facilities for the fabrication of these NON-metallic materials to your specifications, at three strategic points . . . Newark, Delaware . . . Valparaiso, Indiana . . . and Toronto, Canada. Send now for Booklet GF24A.

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* BALTIMORE BOMBER ILLUSTRATION COURTESY OF GLENN L. MARTIN CO.

as the tensile strength of cast iron increases so does the material become more sensitive to notch effect, the endurance limit of a notched cast-iron bar often approaches that of steel. Many investigators have raised the theory that the graphite flakes act as stress raisers. This is not altogether true, as the graphite if in proper form and quantity can help to prevent failure.

For instance, the tough pearlitic matrix of Meehanite contributes high strength to the design, but the graphite flakes will dissipate stress over the whole structure and prevent microscopic cracks from leading progressively to fracture under fatigue stresses. The ill-effect of poor design would be less felt in a Meehanite crankshaft than it would in a steel shaft.

Avoiding Crankshaft Failures

Thum and Meyercordt proved that the torsion fatigue strength and the bending fatigue strength of a smooth bar of pearlitic cast iron are practically equal. Observation of many fractured crankshafts reveals three main types of break, practically all starting in the region of a shaft notch either at the junction between pin and web or at the oil passage.

The three types are: (a) Through the pin, starting at the junction and then proceeding at about 45 deg. in a torsional stress line; (b) across the web where this is generally smaller in cross section than the pin; (c) a combination of both. In cast-iron crankshafts recent studies show that the majority of breakages occur directly across the web, although a fair number show a fairly clean break between the pin and web.

The essential problem of the founder in making cast crankshafts is to produce a material regularly and consistently with physical properties which will withstand fatigue stresses involving bending, torsion and a combination of bending and torsion stresses, also with consistent values of strength, hardness and impact properties etc. All crankshafts should be made in dried sand molds to assist the metal in filling the mold with as little further loss in temperature as possible. If the whole mass does not cool down uniformly, stresses are set up within the casting.

As practically all crankshaft casings are of various shapes and different cross-sectional dimensions, hindered contraction cannot be avoided and stresses are left within the casting. In addition, if the pouring and molding methods are such that the additional metal required to make up liquid shrinkage cannot be got into the mold before solidification takes place, porous patches and zones of weakness may occur at different places in the shaft.

A well-designed cast crankshaft is one whose sections are no thicker than is essential to the desired unit of strength and which are evenly proportioned to avoid undue variations in cooling rates. Cast iron crankshafts for small compressors and the smaller gasoline engines, are now an accepted production.

—E. M. Currie & R. B. Templeton, *Foundry Trade J.*, Vol. 66, Feb. 26, 1942, pp. 133-137; Mar. 5, 1942, pp. 149-151.

Government contractors, needing bronzes for war production service, will find at the Ampco foundries full facilities for producing bronzes to meet the exacting specifications of the Army, Navy and Air Corps.

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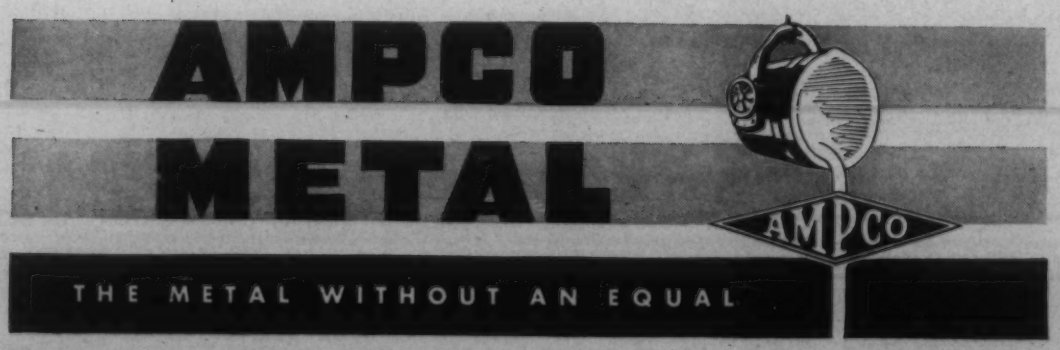

Aluminum Goes to War

Condensed from "Metallurgia"

About forty years ago the demand for aluminum was negligible, but continuous improvements in the production and fabrication, and continuous research to improve its alloys, have contributed to its becoming one of the most versatile of metals. For the duration of the war, it has practically [*in America completely*] disappeared from the materials used in the manufacture of products for non-essential purposes. This article briefly reviews the trend of development and summarizes some of its uses in modern warfare.

The application of aluminum and its alloys received great impetus from the automobile industry, and it was fortunate this new industry was born when the new materials were struggling for recognition. This new industry, starting with a more open mind and a need for light weight and other properties possessed by aluminum alloys, became a substantial consumer. It was the coming of the aircraft industry, however, and the need for light-weight construction of both aircraft and engine, that fostered the development in quality of aluminum alloys and greatly increased their application in recent years.

All the aluminum-producing countries

THE PROPERTIES OF LEAD

Thermal Properties

Melting Point	327.4°C or 621.3° F
Boiling Point	1525° C
Heat in solid at melting point B.t.u./lb.	18.0
Latent heat of fusion B.t.u./lb.	9.9
Total heat in liquid at melting point B.t.u./lb.	27.9
Decrease in volume on solidifying	3.85%
Increase in volume on melting	4.01%
Shrinkage in volume calculated from liquid at melting point to 68°F	5.8%

Thermal conductivity

Temp. °C	0	100	200	400	500	600	700
Conductivity (Calories per cm. per sec.)	.083	.081	.077	.038	.037	.036	.036

TABLE OF MELTING POINTS

Metal	Melting Point °C	Eutectic with Lead % by Weight	Melting Point °C
Lead	327.4	____	____
Tin	231.9	62.	183
Bismuth	271.3	54.9	125
Antimony	630.5	12.5	247
Cadmium	321.0	17.4	249
Zinc	491.45	.5	318

Though not the primary reason for using that metal, the low melting point of lead is of great advantage in calking and casting. By using combinations of lead with two or more of the metals, tin, cadmium or bismuth, alloys which will melt at low temperatures may be made. These find extensive use for such purposes as electric fuses, automatic sprinkler systems and boiler plugs. Solder and type metals are made from the low-melting alloys of lead, antimony and tin.

Pouring and calking lead joints in a 20-in. cast-iron water main in New York City, forming a part of New York's great distribution system of 5,000 miles of cast-iron mains with lead joints and thousands of lead water services.

Type metal vat in Brooklyn plant of New York Daily News.

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contributed and benefited from the results of research and technological progress, but there are indications that the institution of the totalitarian systems is responsible for the artificial increase in production, an increase closely connected with the production of armaments. The first noticeable increase took place in Germany in 1934, with the justification that aluminum being a "German" metal had to replace the then imported metals, principally copper and tin, and to some extent lead.

During the period 1934 to 1939, prior to the present war, the so-called peaceful activities of Germany were indicated by the application of aluminum and aluminum alloys in the production of field-kitchens, water-bottles, reflectors, searchlight carriages, radio equipment, gun-wheels, pontoon bridges, truck equipment, bomb fuses, cartridge cases, magnetic, acoustic and moored mines, paint, cars, buckles, food containers, and many other applications, especially in ship equipment and aircraft construction, and also as a substitute for other non-ferrous metals.

In Great Britain, and later in the United States, it has been possible to divert practically the whole of the aluminum production of these countries to work of military importance. How great the change is not readily appreciated, but when it is realized that the versatility of aluminum and its alloys in 30 major [*peacetime*] industries is represented by some 2,500 applications, it may be understood.

An estimate of the proportion of world consumption in various fields over a 10-yr. period is given as follows:

Industry	Consumption per cent
Aircraft, automobile, railway, marine industries	30
Food industry, cooking utensils	15
Large and small machinery	15
Electric industry: conductors, bus-bars, motors	10
Chemical industry	3
Deoxidizing steel and heavy alloys	7
Powder, foil, seals	4
Non-recoverable scrap	3
Miscellaneous	13

Aluminum in Aircraft

Aluminum, in its relatively short history, has won a predominating position in aircraft engineering. The gross weight of an airplane is made up of the weight of the airframe, accessories, engine, propeller and load. In a 4-engine 25-ton bomber, the structural weight may amount to 35 per cent, leaving about 20 per cent for the power-plant weight and about 45 per cent for the variable load.

The approximate distribution of materials in the structure is shown in the Table, which gives some idea of the position occupied by aluminum relative to other materials.

Weight Analysis of Heavy Bomber in Pounds

Metal	Form	Total Weight
Steel	Low alloy	1,600
	Stainless	600
Magnesium	Castings	50
Aluminum	Sheet	10,500
	Extrusions	500
	Drawn parts	1,500
	Castings	100
	Forgings	400
	Rivets	450
Others	All forms	200
Total for Structure		15,900

Some parts for both the structure and the engine are usually from non-treatable aluminum alloys, but practically all the stressed parts are made of heat-treatable alloys, and sheet is used wherever possible. The parts usually made of non-treatable aluminum in sheet form are cowlings, covers, fairings, leading edge, flooring, tank, unstressed fittings, and many miscellaneous parts.

In some cases magnesium alloys are substituted for aluminum for these parts. In tube form, the parts include fuel and oil lines, air-speed indicator tubes, conduits and other miscellaneous parts.

In engines it is more difficult to differentiate between forged and cast parts because of the varying techniques employed, the type of engine, whether air- or water-cooled, and the stress imposed upon the part. Thus, the crankcase and cylinder heads of water-cooled and small sized radial engines are usually cast; the cylinder head of high-powered air-cooled engines may be cast, but in Britain are usually forged. The piston rod section and covers are sometimes cast for small air-cooled engines, but forged for high-powered ones.

The parts which are nearly always cast are the blower-section, the rear-end section, carburetors, supercharging casing, pump

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For the ENGINEER

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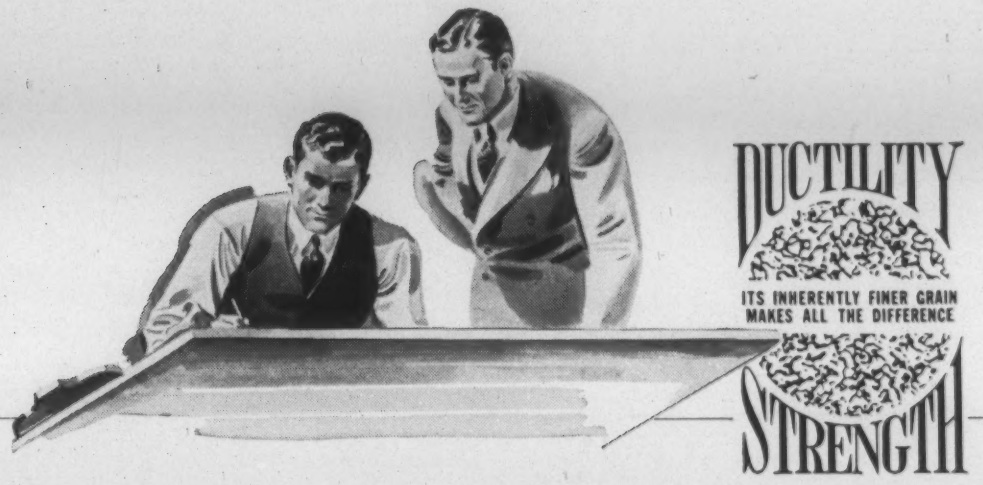

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N-A-X HIGH TENSILE has very high resistance to IMPACT and FATIGUE, regardless of weather conditions —in sub-zero cold or blistering heat. This means that rolling equipment built of N-A-X HIGH TENSILE will withstand the destructive forces of SHOCK, STRESSES, IMPACT and FATIGUE, resulting from rough roads and adverse operating conditions.

N-A-X HIGH TENSILE goes through each step in fabrication smoothly, quickly. Its welding characteristics are excellent, responding equally well to all types. And because it is highly ductile, it can be cold formed with the ease and speed of mild carbon steel.

N-A-X HIGH TENSILE'S other important properties are: high yield point, high ultimate strength and greatly increased resistance to corrosion and abrasion.

For additional information about N-A-X HIGH TENSILE and its use in transportation equipment, or for other applications, ask for a Great Lakes engineer to call. He will show you how hundreds of others are using this remarkable low alloy steel to marked advantage. Save steel for the armed forces and at the same time increase the pay load of your equipment. Specify and use N-A-X HIGH TENSILE.

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housing and intake section. The parts which are mostly forged in radial engines are the 3 main crankcases, supercharger impeller blades, engine support, landing gear, fitting, etc.

Some parts may either be made of aluminum or some other material. This applies to propellers, bearings, and even the crankcase of radial engines. Aircraft parts for which the magnesium alloys are sometimes favored are landing wheels, oil pump, supercharger, front and rear sections, instrument housing, control parts, distributors, accessories, plates, covers, etc.

—Wm. Ashcroft, *Metallurgia*, Vol. 25, Apr. 1942, pp. 157-159

Selecting Gear Materials

Condensed from "Electrical Manufacturing"

The mechanical arrangement of both large and small gears and the correct selection of gear materials are closely interrelated. For example, a single worm reduction made of steel might be preferable to a train of cast iron spur gears.

Selection is complicated by the existence of countless varieties and treatments of each of the familiar gear material types —cast iron, steel, brass, aluminum alloys, zinc alloys, plastics, fiber, etc.—and by the differences in performance resulting from different fabricating methods—forgings, castings, die castings, etc.

Qualities and services should be classified together, so that a suitable material may be matched with the purpose for which it is intended. For example, a list something like the following might be prepared.

Special Property	*Important in*
Quietness	Office machines, oil burner pumps
Dimensional accuracy	Centrifuge
Mechanical strength	Oil well drilling equipment or punch press drive
Accurate positioning	Timing devices
Shock resistance	Railway gears
Heat resistance	Rolling-mill drives
Corrosion resistance	Pumps
Wear resistance	Auto timing gears
Low weight	Portable devices

Of course, two or more of these requirements are usually encountered. An alloy steel gear will provide high strength and shock resistance but may be harder to machine than some other material, say a zinc-base die casting; the latter may possess the required machinability and quietness, but be lower than desired in mechanical strength.

Non-metallic gears are increasing in use and they often provide a useful compromise, particularly where availability or quick delivery is more important than strength. Plastic gears are widely used, the strongest being made from laminated plastics—cloth and paper impregnated with phenolic resins. The life obtained from such gears, properly designed, often exceeds that obtained from steel gears.

Fiber gears are also used to a growing extent. Fiber sheet or plate can be punched (if thin) or machined readily to shape. Although fiber is swelled and distorted by moisture, it resists oil, most weak chemicals or moderate heat. It is "quiet" and requires no lubrication for small gears, although only light loads can be employed.

An (admittedly hazardous) attempt is made to indicate the following general relationships among the various metals and metal-forms for average designs of the same shape and dimensions:

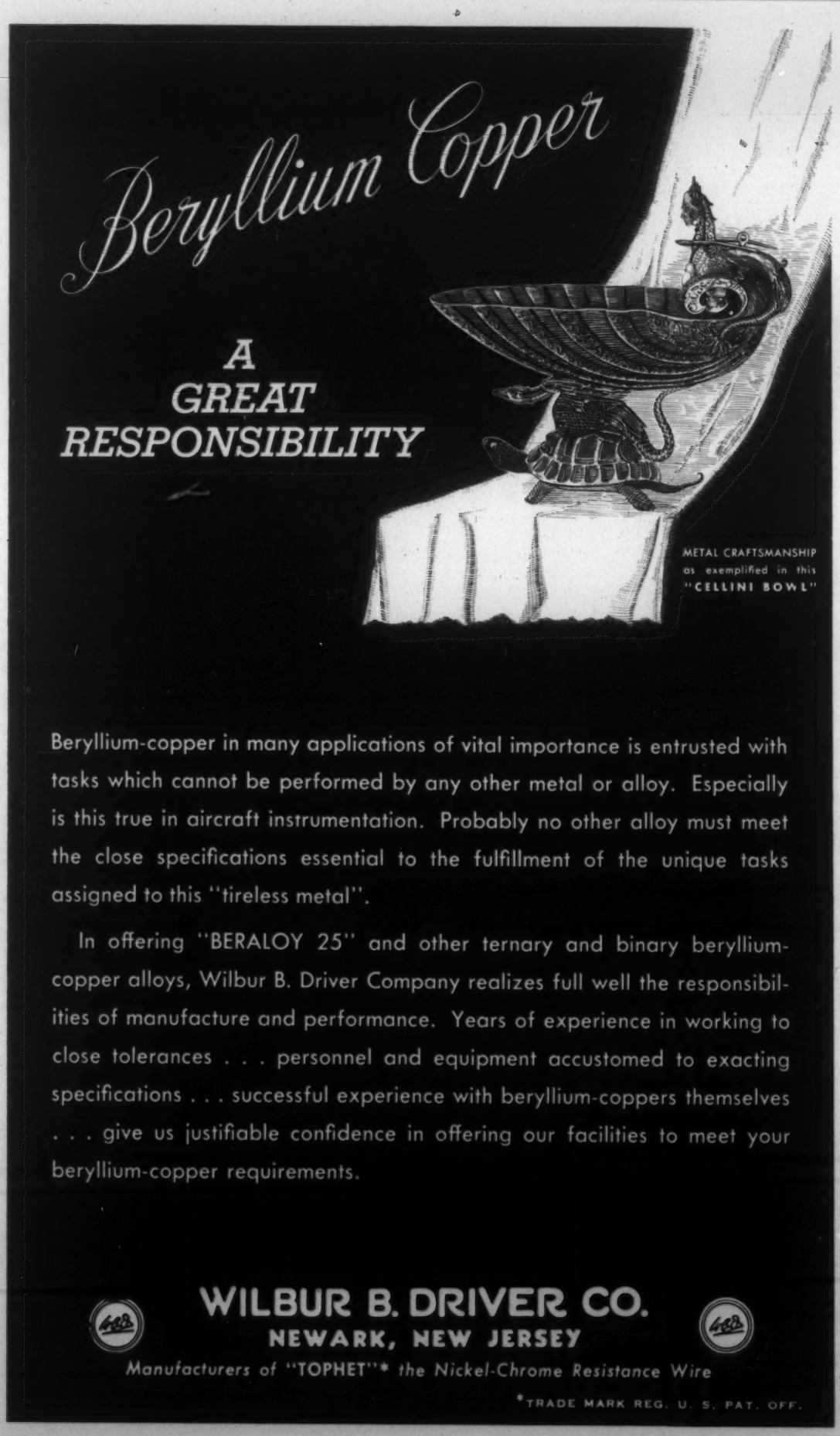
Increasing Quietness	Increasing Machinability	Increasing Strength
steel	alloy steel	fiber
cast iron	carbon steel	molded plastics
brass	cast iron	die castings
die castings	bronze	laminates
plastics	plastics	brass
fiber	brass	bronze
	fiber	cast iron
		steel

—D. F. Miner, *Electrical Manufacturing*, Vol. 29, Mar. 1942, pp. 47-50, 90, 92, 94.

What Solder for Hot Water Lines?

Condensed from "J. Research, Natl. Bur. Standards"

Investigations previously reported have clearly shown the reliability of soldered sleeve joints in copper-tube lines used in domestic plumbing and for various other purposes. A limitation on the maximum temperature for elevated temperature service appeared necessary, however, especially for joints made with solder containing tin.



Beryllium-copper in many applications of vital importance is entrusted with tasks which cannot be performed by any other metal or alloy. Especially is this true in aircraft instrumentation. Probably no other alloy must meet the close specifications essential to the fulfillment of the unique tasks assigned to this "tireless metal".

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Lebanon metallurgists are studying future applications for alloy and carbon steel castings of controlled quality . . . and are ready to discuss significant developments with forward looking organizations.

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Joints made with solder containing tin were considered to be entirely satisfactory for service in which the temperatures did not exceed 250 deg. F. Some lead-base solders, containing no tin, were considered reliable for use at somewhat higher temperatures, 325 deg. F. being the maximum.

A criterion for the complete evaluation of soldered joints of the type discussed here for extended use at elevated temperature is not furnished by strength measurements alone. The possibility of bond deterioration under long-continued heating must be considered also.

Creep, or time-extension, tests at a constant elevated temperature of joints made with 50-50 lead-tin solder showed an initial period, approximately 1,000 hrs., during which extension within the soldered joint normally occurred, the magnitude of the extension being determined by the shear stress acting in the joint. However, this initial behavior was followed by a very great increase in creep resistance in the joint, and during the remainder of the period at the elevated temperature substantially no extension occurred.

Such joints showed a marked decrease in strength, as determined subsequently at room temperature by short-time tensile tests. To determine the nature of the change in the solder underlying this behavior of the joint, a metallographic study of the microstructure of soldered sleeve joints in copper tubing was made. Joints made with solders containing tin and maintained for long periods at 250 deg. F. showed coalescence of the microstructural constituent adjacent to the copper. This is evidently the intermetallic compound, designated as the "bonding-alloy layer" and consisting of Cu_3Sn, which results from alloying of the tin with the copper by diffusion.

Hardness measurements of the bonding-alloy layer by the Knoop micro-indentation method showed it to be very much harder than the solder, the indentation hardness numbers for 50-50 lead-tin solder and alloy layer being in the approximate ratio 14:196. The indentation hardness of the bonding alloy varied somewhat for the different solders but was always higher than that of the copper, which averaged 107.

Fragmentation of the bonding-alloy layer was observed to occur in some cases as a result of the indentation hardness tests. The thickness of the hard, brittle bonding-alloy layer was dependent upon the initial tin content of the solder.

Tin-antimony solder used in sleeve joints, when maintained at an elevated temperature, behaved in essentially the same manner as tin-lead solder. The resulting bonding-alloy layer possessed the same general characteristics, although the hardness was somewhat lower than that of the bonding layer in the lead-tin solder film.

The lead-cadmium alloy showed a progressive growth of bonding-alloy layer at elevated temperature which did not differ markedly in its characteristics from the corresponding constituent in the lead-tin solder films. Pronounced coalescence of the structural constituents occurred in the lead-silver solder maintained at elevated temperature, but substantially no increase in the bonding layer was detected. No evidence of alloying with the copper base was observed in the lead-solder joints after long-continued heating.

—Wm. H. Swanger & Arthur R. Maupin, *J. Research, Natl. Bur. Standards*, Vol. 28, Apr. 1942, pp. 479-487.

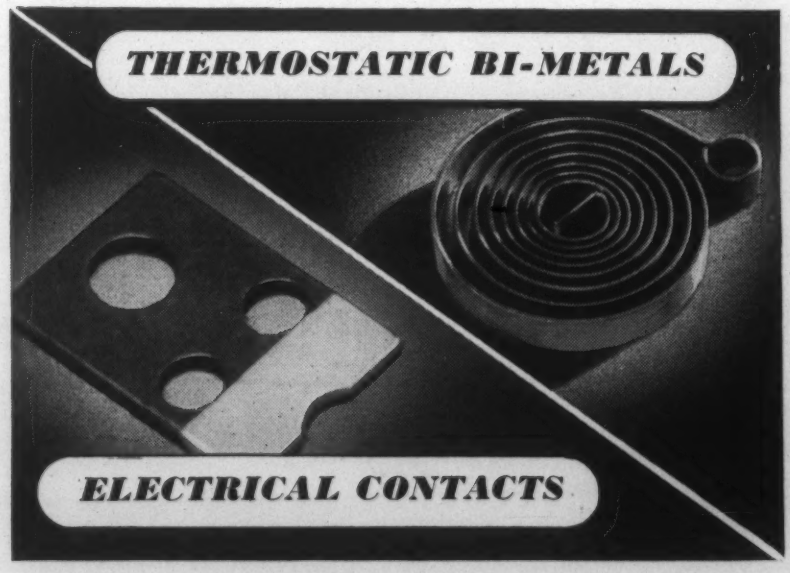
STARTING THIS MONTH

on page 907

"THE PRODUCTION FRONT"

A New Department written by Harold A. Knight

War-Production News, Trends, Forecasts



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Physical and Mechanical Property Testing and Inspection • Routine Control and Instrumentation • X-ray and Magnetic Inspection • Spectrographic and Photoelastic Analysis • Corrosion- and Wear-Testing • Examination of Coatings, Surface Measurements • Metallographic Structure and Constitution

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Radiographic Inspection of Welds

Condensed from "Engineering Inspection"

The application of welding to the fabrication of drums, boilers and pressure vessels has depended on a satisfactory method of non-destructive testing. Actually, the development of welded fabrication in this field has progressed simultaneously with that of radiographic inspection.

As the methods of welding have improved with the advent of specially designed automatic welding machines, so also the efficiency and durability of X-ray apparatus has increased, and it is now looked upon, not as a piece of fragile apparatus used only by research workers in laboratories, but as an integral part of up-to-date workshop equipment. Modern welding methods establish the possibility of fabricating pressure vessels from plates of considerable thickness, and modern X-ray equipment has to be designed to withstand the high voltages and long exposure times necessary for the examination of these thicknesses.

The metallurgical and physical quality of the welds can be ascertained by means of test plates attached to the ends of the shell and welded continuously with the actual seam, and so are truly representative of the deposited metal. These test plates are later subjected to comprehensive tests involving their destruction.

It has been stated that the quality of the welded joint, as determined by means of the test plates, represents the quality of the weld; but there remains the possibility of local defects occurring in the main seam, and it is here the X-ray methods of examination provided the only practical means of obtaining with certainty the position and shape of any such defects as may be present.

Types of Defects

Defects may be classified under 4 headings: (1) porosity; (2) slag inclusions; (3) lack of penetration, or improper fusion; and (4) cracks.

Pores are roughly ellipsoidal voids about 1/16 in. in maximum diam., and they may or may not have a slag content. They may occur uniformly distributed, when this condition is known as general porosity, or they may occur in small isolated groups.

If the porosity is extensive, the cause may be traced to the electrode. An excessive arc length existing momentarily may produce a small group of pores.

There are many other causes, but a good idea of the most probable one, can be gained from a knowledge of the size, uniformity, position and shape of the pores. A spherical pore with a smooth outline is to be considered less dangerous than one with rough and irregular edges.

Slag inclusions have an irregular outline and are usually the result of slag flowing in front of the arc preventing complete fusion of the metal beneath, and finally becoming trapped under the advancing pool of metal. In some cases they form quite large defects.

Lack of penetration is normally combined with slag inclusions, and the two types o. flaw may merge into one another. The molten metal from the end of the electrode has failed to fuse with the parent metal, or

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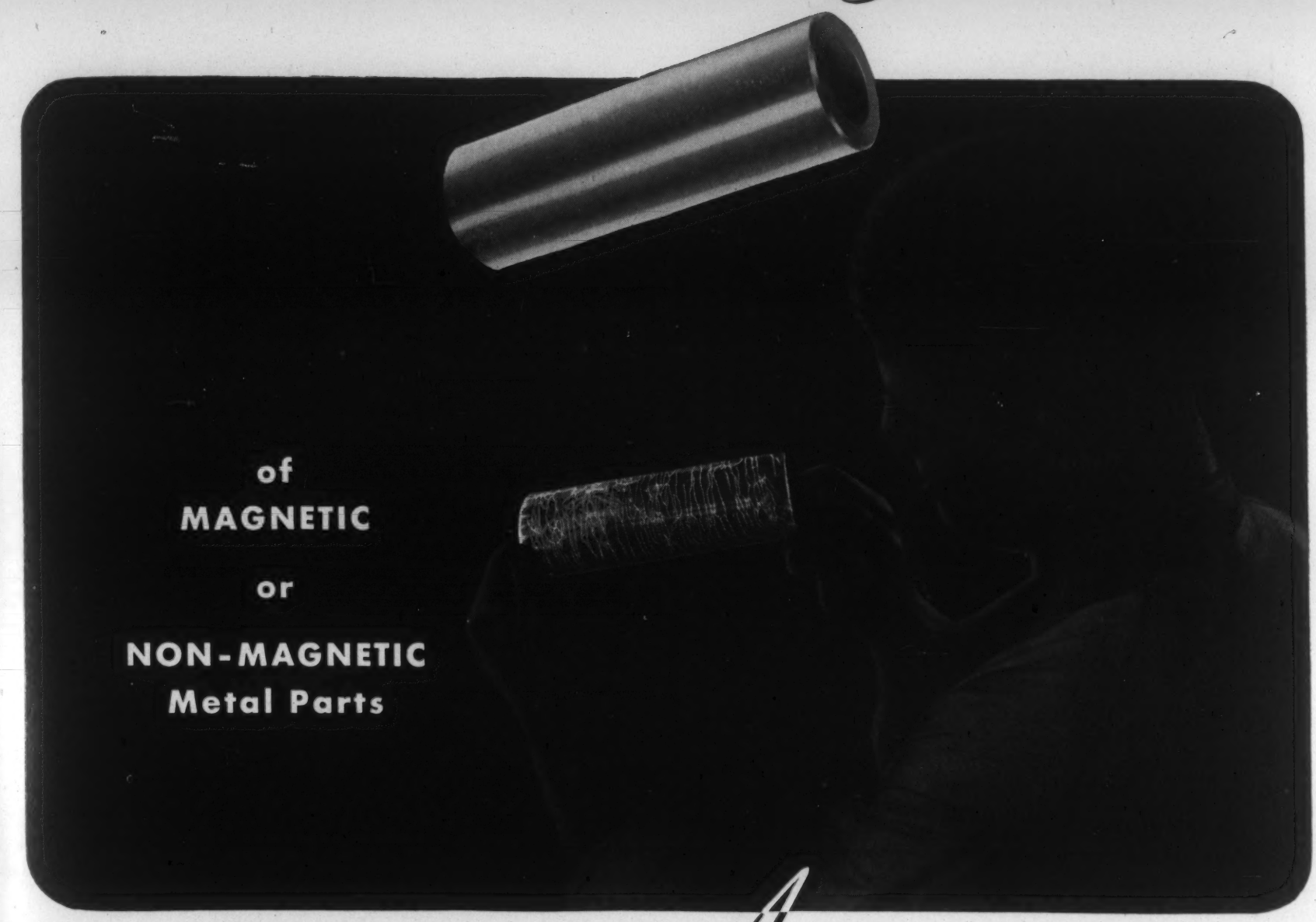

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Correspondence on applications is invited

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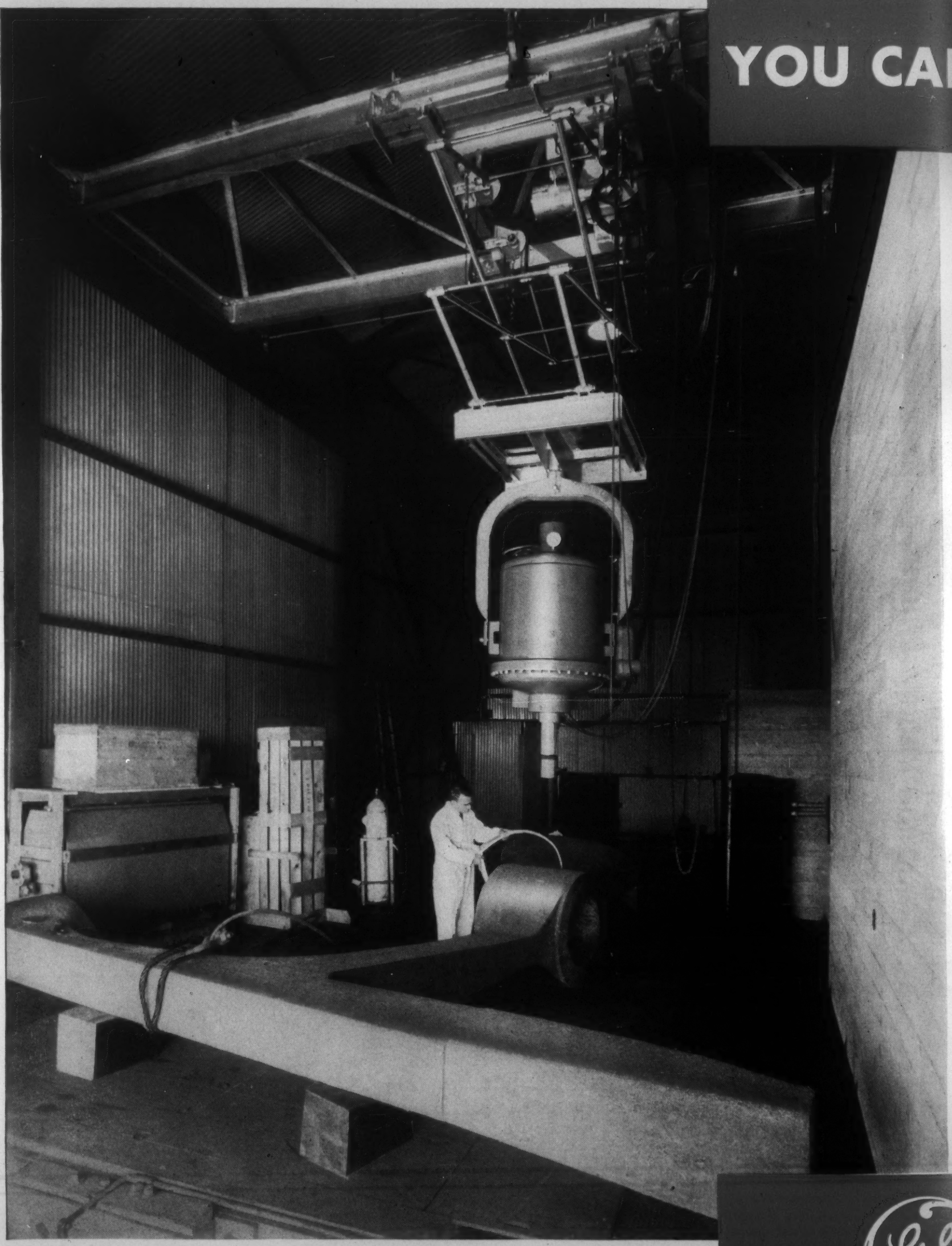

WORLD'S MOST POWERFUL *is this G-E one-million volt industrial x-ray unit. Mounted on a traveling overhead bridge crane, this unit provides unusual flexibility to expedite the handling and radiography of large castings of various metal thicknesses—from one inch on up. Fast, safe, shockproof, it is but one unit of the complete line of G-E Industrial X-Ray apparatus.*

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the weld metal below, with the result that an area of lack of fusion exists in the shape of a fine line, broadening out at intervals signifying the presence of trapped slag.

There are many possible reasons for the presence of this type of fault, for example too low a current, too short an arc, wrong position of the arc, an irregularly shaped groove, or the surface of the preceding layer has been very uneven.

Cracks may occur in the weld itself, or in the plate material adjacent to the weld, and invariably in a plane at right angles to the plate surface. This is a fortunate circumstance since the detection of a crack by X-rays is more certain, the more nearly the plane of the crack approaches the normal to the plate surface.

Cracks are caused by high concentrations of stress set up in the course of welding. Normally internal welding stresses attain a high magnitude, but when combined with some unfavorable circumstance, such as an area of lack of fusion, the local stress concentration may become excessive and a crack may be propagated.

Diagnosis and Interpretation

From the point of view of their effect on the mechanical efficiency of the welded joint, the importance of the various types of flaws increases in the order which has been given, that is, porosity, inclusions, lack of penetration, cracks. Unfortunately, the last two are often the most difficult to detect in X-ray examination, and the slightest appearance of a line or crack upon the radiograph is regarded with suspicion and supplementary radiographs are taken at a different angle.

A certain degree of porosity and even of small slag inclusions may be accepted as having no appreciable effect on the reliability of the joint, but here the shape of the flaws and their mutual proximity have to be considered. The more clearly the radiograph demonstrates these points, the easier it is to make a definite decision as to their possible seriousness, and thus avoid the work involved in carrying out what may be unnecessary work in the elimination of the defect.

Any improvement in radiographic technique that increases the definition and gives consistent density, correspondingly increases the advantages obtained from this method of non-destructive inspection.

Although a great deal of experience is not required to operate the X-ray unit and expose the film, the interpretation of the radiograph presents an entirely different aspect of radiology. In multi-layer welding, the affected area does not usually involve more than one or two layers of metal, except where possibly gross inclusions are present or where, owing to highly concentrated areas of stress, the weld may have fractured through a number of layers.

A comprehensive knowledge of the radiographic appearance of the various types of inclusions is essential, if one is to determine just how serious a particular flaw may be. Taking into consideration the thickness of the weld, the size and shape of the inclusion, and the working pressure of the vessel, the experienced eye can quickly decide whether or not the presence of such an inclusion would be likely to affect the efficiency of the weld.

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Some Aids to Improved Technique

Within recent years lead foil intensifying screens have contributed greatly to the diagnostic value of radiographs, but their use on thick materials makes the greatly increased exposure times incompatible with the diagnostic value derived from the radiograph. It is only when some doubt arises in the interpretation of a film exposed with salt screens, that the additional information supplied by a lead screen radiograph makes the greatly increased exposure time worth while.

It is difficult to quote any hard and fast technique for any particular thickness, as opinions differ on this subject, but it is generally agreed that the focal film distance is of paramount importance. Although the working life of the X-ray tube is always to be considered, it is not advisable to reduce the distance beyond a critical figure for the purpose of reducing the tube load to a minimum.

On thickness of the nature of ½ to 1¾ in., using an X-ray tube with a target area of 5 mm., a focal film distance of 24 in. may be considered satisfactory. Using a tube with a target area of 9 mm., it is advisable to increase the focal film distance to 36 in. to counteract the size of the focal spot which is characteristic of the higher powered units.

To supply the accurate results demanded by present-day standards, some form of telescopic focussing device is necessary, which can be set at a pre-determined length and which ensures that the focal film distance remains constant for each radiograph. The focussing rod should be set at right angles to the weld in both planes. It is also to be remembered that in stereoradiography, a deviation of even half-an-inch off center will upset the final calculations.

—J. J. Gillespie, *Engineering Inspection*, Vol. 6, Winter 1941, pp. 15-20.

Pyrometry of Liquid Steel

A Composite

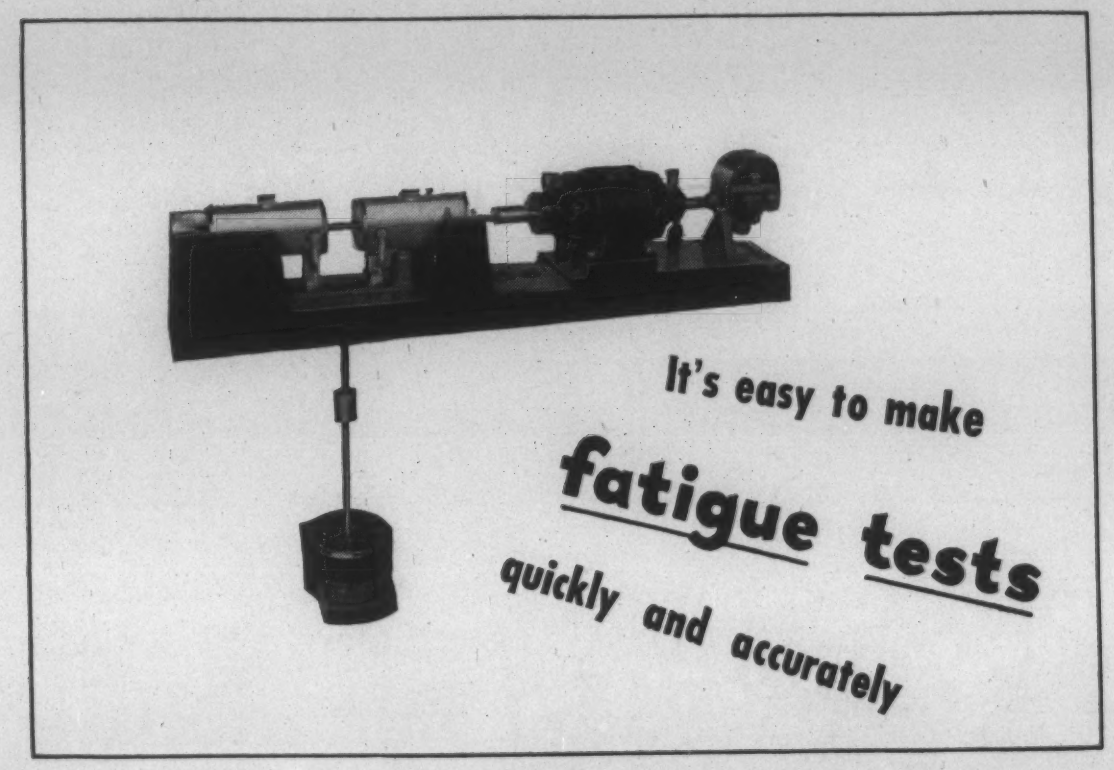
Several reports from England have recently dealt with temperatures of liquid steel, but they have not given reliable and cheap methods for determining true temperatures of liquid steel. The technique described for noble metal couples protected with silica tubes is reported to give reliable temperature measurements, but this is a relatively expensive method, at least with the present price of silica tubes in America.

The Committee on the Heterogeneity of Steel Ingots ("Third Report of the Liquid Steel Temperature Sub-Committee," *Iron & Steel Inst.*, Adv. Copy, Jan. 1942, 31 pp.) gives data on the use of platinum thermocouples lightly sheathed in silica. With this technique a refractory block is mounted on one end of a pipe and the open end of a small silica tube is inserted in a hole in the refractory. The junction of the couple is near the closed end of the silica tube and the couple leads pass through the refractory block and then through the pipe. The whole assembly may be light enough so that it can be inserted manually into the open hearth or it may be mounted on wheels and rolled up to the furnace door.

Different types of assemblies used at several British plants are described. It is suggested that besides a millivoltmeter and potentiometer there exists the possibility of a third type of indicator, which consists essentially of a combination of mirror-galvanometer, photocell and valve by which the current is automatically adjusted in a circuit, so that the e.m.f. on a fixed resistance in that circuit balances the e.m.f. of the thermocouple. The e.m.f. of the couple is thus expressed in terms of the current given by a milliammeter, the readings being independent of variations of resistance in the couple circuit.

While complete temperature control may prove to be possible on the basis of single readings of the quick-immersion thermocouple, this may prove difficult of attainment, at any rate in the larger furnaces. It may be worthwhile to consider the possibility of other methods as alternative, or supplementary, to the use of the thermocouple.

Thus, a photocell pyrometer might be devised, which, by virtue of its rapid response, would enable temperatures to be recorded for a considerable sweep of the instrument on each insertion. Such an instrument might consist of a photocell sighted at short range into a silica tube.



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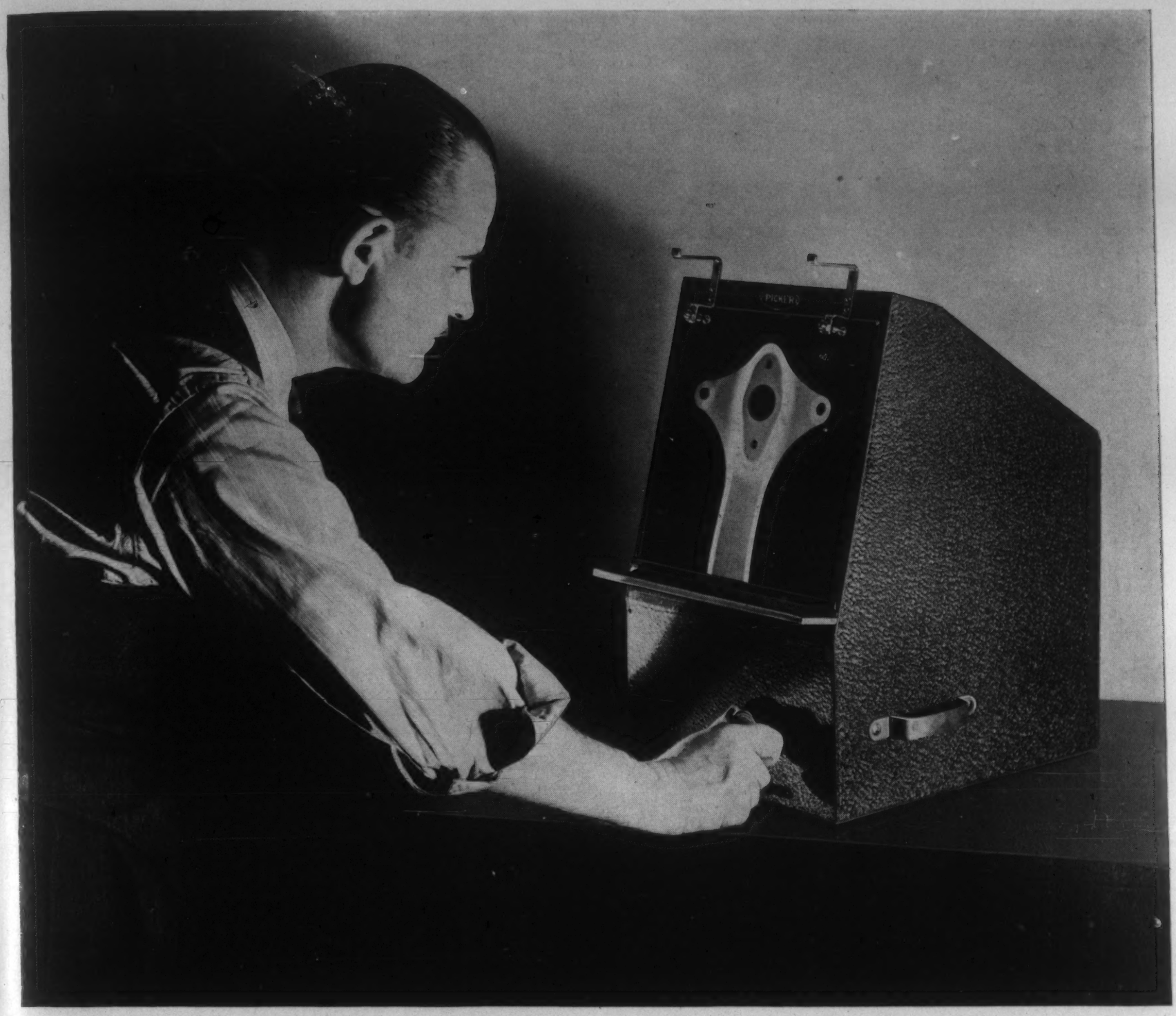

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Use might also be made of comparative measurements of the electrical resistance of part of the bath as a means of getting the average temperature. The measurements of resistance, apart from their use for checking temperatures, might be of interest in themselves.

[*The reader is referred to the chapter (p. 937) "A Quick-Immersion Technic for High - Temperature Measurements on Fluids," by F. H. Schofield & A. Grace in the book, "Temperature—Its Measurement and Control in Science and Industry," sponsored by the American Institute of Physics, and published by Reinhold Publishing Corp., New York, in 1941. These authors have developed a so-called "quick-immersion" technique which enables liquid-steel temperatures to be readily measured by a platinum couple up to the highest limit required—namely 3100° F.*

According to their method the couple, lightly sheated in silica, is plunged into liquid steel in such a way that a reading can be obtained in a few seconds and the couple withdrawn intact. The wastage of material and depreciation of the couple on each insertion have been rendered unimportant.

The quickest response was obtained with a thermocouple having 0.3 mm. wires and a silica sheath of 0.5 mm. wall, and was of the order of 3 or 4 sec., while the slowest response was 15 sec., given by a 0.5 mm. couple in a sheath of 2 mm. wall.—A.I.K.]

Temperatures throughout the making of several heats are given. Temperature measurements in an electric furnace are also given. The results all look reasonable and there is good reason to believe that true temperatures were determined.

In a report of the Steel Castings Research Committee, T. Land ("The Ladle Cooling of Liquid Steel," *Ibid.*, Nov. 1941, 12 pp.) makes some estimates on heat losses and from them calculates the drop of temperature of steel held in a ladle. Experiments with oil showed that a liquid cools by a relatively thin layer of liquid passing down the sides of the container and forming a reservoir of cool liquid at the bottom. A table is given showing the difference between tapping temperature and mean casting temperature for weights of metal from 1 to 100 cwt. For 100 cwt. of metal, the temperature drop is given as 68° F. in 20 min., 117° F. in 60 min., and 165° F. in 120 min.

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New Creep Testing Apparatus

Condensed from "J. Research, Natl. Bur. Standards"

The creep-testing apparatus recently installed at the National Bureau of Standards, whose application to a study of cold-drawn Monel is described in this article, presents some interesting features. It consists of 12 independent units for testing specimens having a 4-in. reduced section. On a 0.505-in. diameter specimen, loads from 80 to 90,000 lbs. per sq. in. can be conveniently applied.

The temperature is controlled within ±5°F. up to 1,200°F., and the extensometer readings have a probable error of less than 0.00004 in. The extension is measured between the shoulders of the specimen, so that a correction is required, but the accuracy of the corrected extension averages within 1.5 percent.

Time-extension data were obtained with specimens of severely cold-worked nickel-copper alloy (Monel). The stress range investigated covered the full range of the apparatus, while the temperatures used varied from 700° to 1225°F. In general, one specimen was tested at a single temperature and a series of different stresses.

The results show that a nearly constant creep rate, characteristic of the stress-temperature combination, was attained after a period of adjustment. The use of a single specimen for a series of stresses allowed more rapid determination of this characteristic rate than a single load test. With a single specimen, therefore, a series of characteristic creep rates could be determined, for different applied stresses.

One series of tests, made under a single load at a series of different temperatures, resulted in little or no period of adjustment, yet these rates were consistent with those determined from the constant-temperature tests. The results as a whole indicate that there was only one characteristic rate for each stress-temperature combination irre-

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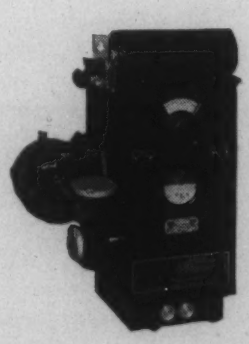

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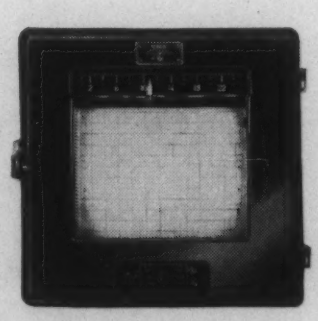

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spective of the previous stresses or temperatures.

Diagrams are given showing the relationship between the variable stress, temperature, and creep rate. No mathematical function could be found to describe the creep test data.

—J. A. Bennett & D. J. McAdam, Jr., *J. Research, Natl. Bur. Standards,* Vol. 28, Apr. 1942, pp. 417-437.

Hardness Conversion Data for Cartridge Brass

Condensed from "A. S. T. M. Bulletin"

The current pressing need for information on hardness conversion relations for cartridge brass has led a special sub-committee of the A.S.T.M. to prepare a proposed table of data on the relationship among diamond pyramid hardness, Rockwell hardness and Brinell hardness of cartridge brass (70 per cent Cu, 30 Zn).

The tables are the result of a series of round-robin tests conducted by the Frankford Arsenal, American Brass Co., American Rolling Mill Co., Wilson Mechanical Instrument Co. and Bell Telephone Labs.

Proposed Hardness Conversion Table [condensed] for use on Cartridge Brass

Diamond Pyramid Hardness Number	Rockwell Hardness Number		Rockwell Superficial Hardness Number			Brinell Hardness Number	Diamond Pyramid Hardness Number	Rockwell Hardness Number		Rockwell Superficial Hardness Number			Brinell Hardness Number
	B Scale, 100-kg. Load, 1/16-in. Ball	F Scale, 60-kg Load, 1/16-in. Ball	15-T Scale, 15-kg. Load, 1/16-in. Ball	30-T Scale, 30-kg. Load, 1/16-in. Ball	45-T Scale, 45-kg. Load, 1/16-in. Ball	500-kg. Load, 10-mm. Ball		B Scale, 100-kg. Load, 1/16-in. Ball	F Scale, 60-kg. Load, 1/16-in. Ball	15-T Scale, 15-kg. Load, 1/16-in. Ball	30-T Scale, 30-kg. Load, 1/16-in. Ball	45-T Scale, 45-kg. Load, 1/16-in. Ball	500-kg. Load 10-mm. Ball
45	..	40.0	..	..	..	42	122	68.0	96.0	83.0	62.0	42.0	108
47	..	45.0	..	..	..	44	126	70.0	97.0	83.5	63.0	44.0	112
50	..	50.5	55.5	..	..	47	128	71.0	97.5	..	63.5	45.0	113
54	..	56.5	58.5	12.0	..	50	130	72.0	98.0	84.0	64.5	45.5	114
58	..	61.0	61.0	18.0	..	53	132	73.0	98.5	84.5	65.0	46.5	116
62	12.5	65.0	63.5	23.0	..	57	136	74.5	99.5	85.0	66.0	48.0	120
66	18.5	68.5	66.0	28.0	..	61	140	76.0	100.5	85.5	67.0	50.0	122
70	24.5	71.8	68.0	32.0	..	63	144	77.5	101.5	86.0	68.0	51.5	126
74	30.0	74.8	70.0	36.0	1.0	66	150	80.0	..	86.5	69.5	53.5	131
78	35.0	77.4	71.5	39.5	7.5	70	156	82.0	104.0	87.0	70.5	55.5	136
82	40.0	80.0	73.0	43.0	12.5	74	162	84.0	105.0	87.5	..	57.5	141
86	44.0	82.3	74.5	45.5	17.0	77	168	86.0	106.0	88.0	73.0	59.0	146
90	47.5	84.4	75.5	48.0	21.0	80	172	87.5	106.5	..	73.5	60.0	149
94	51.0	86.3	77.0	50.5	24.5	83	174	88.0	..	88.5	74.0	60.5	150
98	54.0	88.0	78.0	52.5	28.0	86	180	90.0	107.5	..	75.0	62.0	156
102	57.0	89.8	79.0	54.5	30.5	90	182	90.5	108.0	89.0	..	62.5	157
106	59.5	91.2	80.0	56.0	33.0	94	186	91.5	108.5	..	76.0	63.5	161
110	62.0	92.6	80.5	58.0	35.5	97	190	92.5	109.0	..	76.5	64.5	164
114	64.0	94.0	81.5	59.5	38.0	101	196	93.5	110.0	90.0	77.5	66.0	169
118	66.0	95.0	82.5	60.5	40.0	105							

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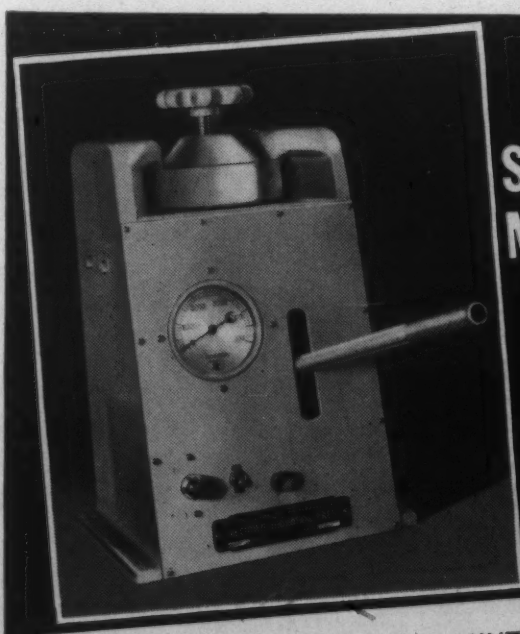

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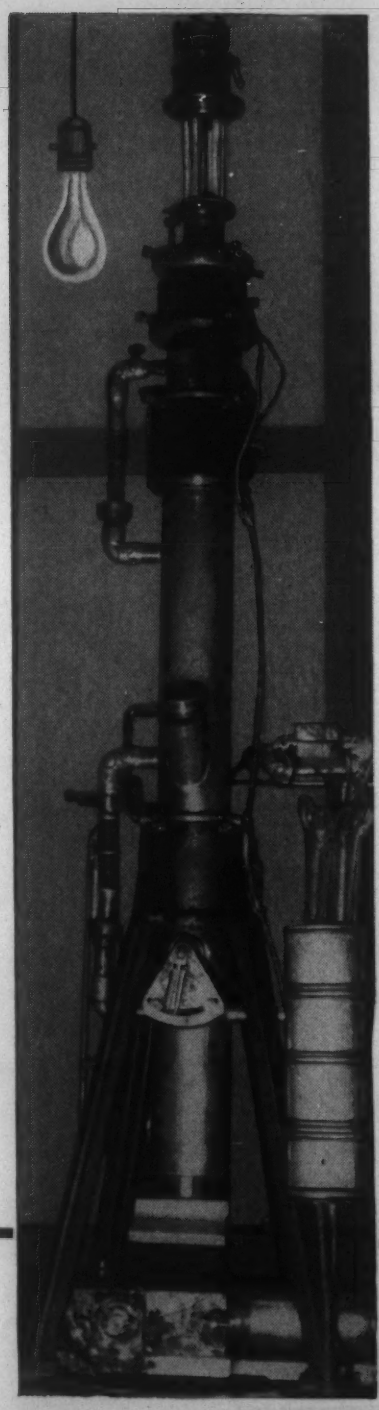
Cutting edge of Razor Blade under the electron microscope.



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"Anyone who wishes to understand how an electron microscope works will find that the reader does not need even an elementary knowledge of optics or electricity if he reads this book because it is all explained here in a delightfully simple and easy fashion. It would serve as an excellent textbook of those subjects."—Science News Letter.

Meet the Authors

Dr. E. F. Burton is head of the Department of Physics at the University of Toronto, which has the distinction of possessing one of the largest and best-equipped physical laboratories in America. Dr. W. H. Kohl, formerly associated with him, is now Development Engineer of the Rogers Radio Tubes Co., Ltd., of Toronto. The first electron microscope in America was built in 1938 under their supervision by two post-graduate students, James Hillier and A. Prebus. The former is now in charge of electron microscope development at RCA Laboratories, Camden, N. J. There he has designed commercial electron microscopes, now being installed in industrial research laboratories throughout the country. Many of the photographs in this book were taken by him.

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—J. R. Townsend, *A.S.T.M. Bulletin*, No. 115, Mar. 1942, pp. 35-36.

Structures of Titanium Steels

Condensed from the "Journal of the Iron & Steel Institute"

A microscopic examination was made of the structures of titanium steels containing from 0.1 to 1.0% C and from 0 to 6.0% Ti.

Special attention was paid to the impurity constituents that are usually referred to as titanium nitride. These were shown to consist of a whole series of particles ranging from yellow through orange through brown to gray, the gray particles being almost indistinguishable from titanium carbide, TiC.

The general effect of increasing carbon was to change the predominant color from yellow to gray, but the particles in any one steel were very variable, and duplex or rimmed particles were often observed with yellow or orange interiors and brown or gray rims.

Residues were extracted from the steels by electrolytic attack in hydrochloric acid, and were submitted to chemical analysis and X-ray examination. The chemical tests showed that the yellow, orange and brown particles were attacked by chlorine at 575 deg. F., with the liberation of free carbon and formation of volatile titanium chloride, whereas titanium carbide is unattacked and titanium nitride is attacked with the formation of volatile titanium chloride. The analyses suggested that in the orange and brown crystals some of the nitrogen of titanium nitride was replaced by carbon.

X-ray investigation of the residues showed that the yellow, orange and brown crystals gave rise to diffuse diffraction lines corresponding to face-centered cubic structures with lattice spacings between titanium carbide and titanium nitride. The diffuseness of the lines varied greatly in different residues.

The microscopic, analytical and X-ray results all agree with the hypothesis that a continuous series of solid solutions exists between titanium carbide and titanium nitride, and that a given steel may contain certain particles of widely different compositions.

—Wm. Hume-Rothery, G. V. Raynor & A. T. Little. *J. Iron & Steel Inst.*, Adv. copy, Mar. 1942, 11 pp.

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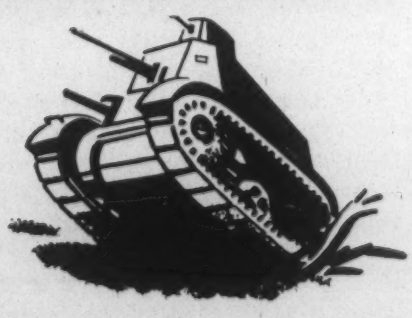

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FOR METALLURGICAL ENGINEERS

Aircraft Metallurgical Design

AIRCRAFT MATERIALS AND PROCESSES. 2ND EDITION. *By G. F. Titterton. Published by Pitman Publishing Corp., New York, 1941. Cloth, 6¼ x 9¼ in., 340 pages. Price $3.50.*

This potentially very useful book has been revised at a time when information on materials and processes of special interest to the aircraft-manufacturing engineer is badly needed. The production of aircraft and the consumption of metals and metal-forms therefor have grown at such a phenomenal pace that many aircraft plants are still without adequate "metallurgical" personnel; the design and production engineers are therefore scrambling for every bit of information about metals and metal-working they can locate.

Mr. Titterton's close-packed volume summarizes for these hard-pressed engineers the essential information they need as a background for selecting materials and fabricating processes. Properties, behavior and processing factors are considered from the *engineer's* viewpoint—which is the most practical possible viewpoint under today's conditions of urgency. The author is assistant chief engineer of Grumman's Bethpage plant and writes from many years of practical aircraft engineering experience with the materials covered.

Engineering steels, steel heat treatment, surface hardening, hot and cold working, corrosion-resisting steels, nickel alloys, copper alloys, aluminum alloys, magnesium alloys, wood and glue, fabrics and dope, plastics, etc., are discussed in separate chapters; in each case the practical processing and design factors that the engineer needs to understand about the respective type of material are presented. There is a useful section on testing, and one on selection of materials, the latter organized according to aircraft parts and components.

A few metallurgical flaws appear, such as the statement on p. 4, under the definition of "hardening," that aluminum alloys are hardened by heating to above 900 deg. F. and quenching. But this slip can almost be ignored in view of very complete and accurate instructions for heat treating aluminum alloys given in the chapters on aluminum, and, as a whole, the real value of the book far outweighs its few minor errors in definition or explanation.

—FRED P. PETERS

Arc Welding

PRACTICAL ARC WELDING. *By W. J. Chaffee. Published by Hobart Trade School, Inc., Troy, Ohio, 1942. Fabrikoid, 5¾ x 8¼ in., 516 pages. Price $2.00.*

This book should be of most value as an instructional manual for students, welders and instructors, but it contains a large amount of general information and technical data which is of interest to engineers.

Most of the material deals with the arc-welding of plain carbon steels, although there is some information on alloy steels, cast iron, non-ferrous metals, and also a section on the carbon-arc welding of copper.

Part I consists of general information on the applications of arc-welding; available metals and alloys; electrodes and filler rods; the design and strength of welded joints; characteristics of the welding arc; and welding symbols.

Parts II and III are devoted to a series of welding lessons as offered in the Hobart Trade School. Included are instructions in manipulation of the arc; bare and covered electrodes; all-position welding; pipe welding; light gauge welding; the welding of cast iron; and welding with the carbon arc.

Part IV reproduces the tentative definitions of welding terms approved by the American Welding Society.

Part V consists of tabular data such as weights and measures, physical constants and conversion tables.

The book is well illustrated with numerous half-tones, diagrams and drawings, which are a distinct asset to the text. The textual material is well arranged and readably written. The book is recommended as a good addition to any welding library.

—C. B. VOLDRICH

Foundry Cores

MODERN CORE PRACTICES AND THEORIES. *By Harry W. Dietert. Published by American Foundrymen's Assoc., Chicago, 1942. Cloth, 6¼ x 9⅜ in., 532 pages. Price $5.00 to members of the AFA and $8.00 to non-members.*

The name of Dietert immediately lends authority to any discussion concerning the use of sands in foundry practice. This new book is an extended compilation of material which Mr. Dietert presented in lecture form at the 1941 and 1942 conventions of the A.F.A.

There are 20 chapters which deal with the various phases of the production of foundry cores. Not only are core sands and core mixtures discussed but there is an important chapter on core binding materials. Two important topics which are fully treated are core making methods and equipment and core mixtures for steel, gray iron, malleable, brass, bronze, aluminum, copper and magnesium castings, both sections fully illustrated.

Naturally considerable space is devoted to the testing of cores and their sands. Other topics included are: Controlling Core Properties, Core Setting, Core Shake-out, and Core Reclamation. The effect of core-sand mixtures in casting surfaces and the defects caused by faulty cores are also discussed. We cannot think of any phase of the core-making industry not covered by the author.

Chapter 21 is a valuable bibliography of 12 pages, divided into two sections: Publications of the A.F.A. and Other Sources. A mildly discordant note is introduced in the presence of about 44 pages of advertising.

—EDWIN F. CONE

Machine-Processing of Metals

METAL PROCESSING. *By Orlan W. Boston. Published by John Wiley & Sons, Inc., New York, 1941. Cloth, 6¼ x 9¼ in., 630 pages. Price $5.00.*

This text was written as an elementary college text and it adequately accomplishes this objective. It consists of general descriptions of the many types of machine tools as well as of information on the cutting tools used with each machine. The book should be useful as a means of introducing the novice to the machine shop.

To the best of the reviewer's knowledge, no other book on this subject exists and it is gratifying that a start has been made towards filling a need of long standing. It is to be hoped that other books on this subject will appear that will be less elementary and will include critical discussions of design features and capabilities of various machine tools. If such information were to be included in future revisions of this book, its utility would be extended considerably beyond that of a college text.

—R. W. DAYTON

Metal Treatment and Inspection

HEAT TREATING AND INSPECTION OF METALS. TECHNICAL MANUAL NO. 1-423. *Published by the War Department, Washington, D. C., 1941. Cloth, 5¾ x 9 in., 49 pages. Price 10 cents.*

This manual, prepared by the Air Corps, discusses in very concise fashion the principles of heat treating, specific heat treatments for aircraft steels and aluminum alloys, hardness testing, and Magnaflux inspection.

There is no superfluous word. In general, the statements made are accurate and form a reasonably good introduction for one with no previous knowledge. However, the introductory sentence to the section on carburizing is a bit weird. It says "when steel is heated, the pores of the metal expand allowing it to absorb any gases to which it is exposed." Complex steels containing chromium are called "chrome" steels, while the plain chromium steels are given the proper term "chromium."

A good feature is the emphasis placed on the need for judgment in the interpretation of Magnaflux indications.

—H. W. GILLETT

Other New Books

INDUSTRIAL CONTROLLED ATMOSPHERES. REVISED EDITION. *By Norbert K. Koebel. Published by Lindberg Engineering Co., Chicago, 1942. Cloth, 6¼ x 9½ in., 97 pages. Price $1.00.* An excellent and unbiased technical discussion of controlled atmospheres, with comparative data and a wealth of practical information. Fully covers all important atmosphere types in established use for over a year.

REFRACTORIES—THE BACKBONE OF INDUSTRY. *By John D. Ramsay. Published by North American Refractories Co., Cleveland, Ohio, 1941. Cloth, 6¼ x 9¼ in., 116 pages. Price: Free to those interested.* A readable, largely non-promotional portrayal of the refractories industry—its history, development, present products and markets, etc.

AMERICAN YEAR BOOK. *Edited by W. M. Schuyler & A. B. Hart. Published by Thos. Nelson & Sons, New York, 1942. Cloth, 5½ x 8 in., 1054 pages. Price $8.50.* Described as "a record of events and progress for 1941"—actually an American encyclopedia for 1941. Contains hundreds of brief articles in the fields of history, politics, business, engineering, science, sociology, etc. Relevant to the metals field are articles on gold and silver, iron and steel, non-ferrous metals, automotive engineering, mechanical engineering, etc.

TECHNICAL HANDBOOK. *By E. L. Page. Published by N. W. Henley Pub. Co., New York, 1942. Wire-bound paper, 5½ x 8½ in., 64 pages. Price $1.00.* A handy compilation of formulas, tables, laws, conversion factors, physical and chemical constants in the fields of engineering, chemistry, physics, mechanics and mathematics—the most-used data ordinarily scattered throughout many handbooks.

HANDBOOK OF WELDED STEEL PLATE CONSTRUCTION. *Published by Buffalo Tank Corp., Buffalo, N. Y. and Dunellen, N. J., 1942. Simulated leather, 6¾ x 9½ in., 288 pages.* There are 12 sections to this handy reference book. These cover such subjects as Steel Plate Construction, Storage Tanks, Pressure Vessels, Tank Heads, Smoke Stacks, etc., with a concluding one on Engineering Tables—all well illustrated and including welding and design data.

AN OIL BURNER HANDBOOK—2D EDITION. *By L. J. Whelan. Published by Master Plumber & Heating Contractor Magazine, Brooklyn, N. Y., 1942. Distributor, Landau Book Co., Inc., New York. Cloth, 5½ x 7¾ in., 245 pages. Price $2.50.* This brief handbook, written by Mr. Whelan who is in charge of the oil burner department of the New York Technical Institute, deals largely with installations in houses and the like. One of its three parts deals with industrial oil burners and covers fuel oil, burners, preheaters, storage tanks and piping, boilers, controls, etc

METAL STATISTICS, *1942. Published by the American Metal Market, New York, 1942. Cloth, 4¼ x 6¼ in., 736 pages. Price $2.00.* This 35th annual edition brings up to date wherever possible, this valuable collection of statistical data. New data on scrap are introduced as is also an enlargement of the magnesium section with new information. In the iron and steel section there is a new table showing annual pig iron and ferro-alloy operating rates and capacities.

PROPERTIES OF CARBON AND ALLOY STEEL TUBING FOR HIGH TEMPERATURE-HIGH PRESSURE SERVICE. *5th Edition. Published by Babcock & Wilcox Tube Co., Beaver Falls, Pa., 1941. Paper, 8½ x 11 in., 156 pages. Free to interested engineers.* Like the earlier editions (see, for example, the review on p. MA 63 of METALS AND ALLOYS for Jan. 1939), this highly useful technical bulletin is concerned only with tubes and confined to those made in quantity production by Babcock & Wilcox Tube Co., but gives, nevertheless, a very complete survey of the entire range of wrought steels for high temperature service. Much more than the usual "manufacturers' literature," the pamphlet is a far better introduction to the topic of steels for high temperature use than appears in most textbooks or handbooks.

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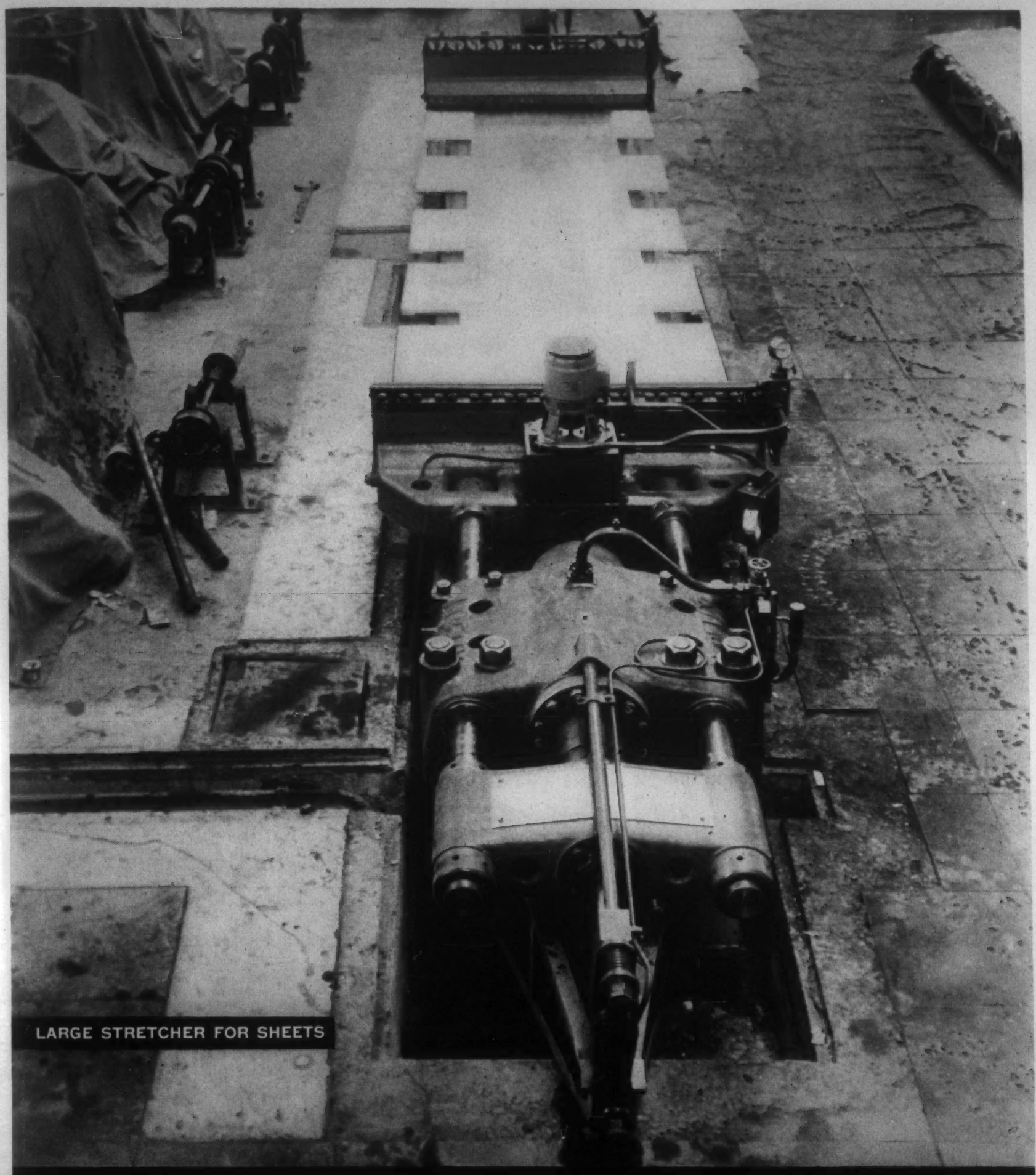

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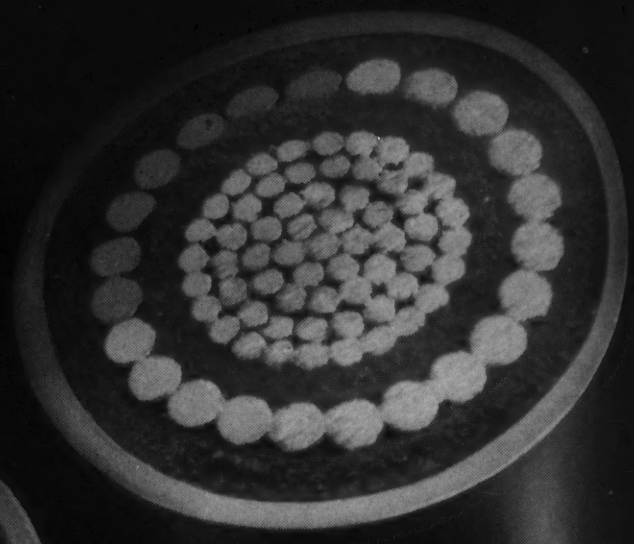

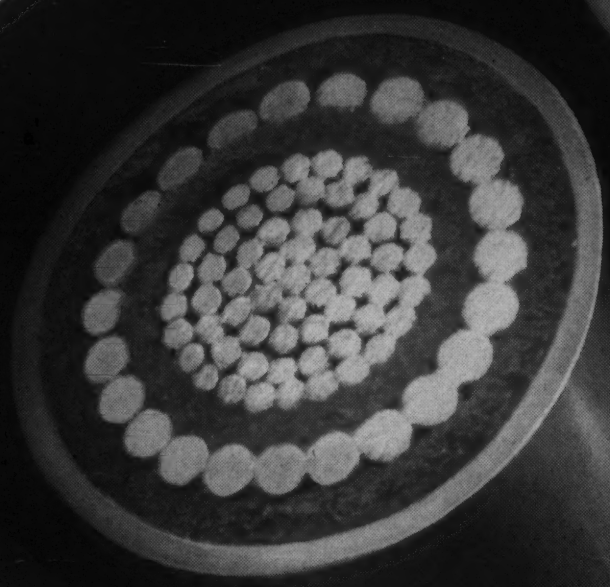

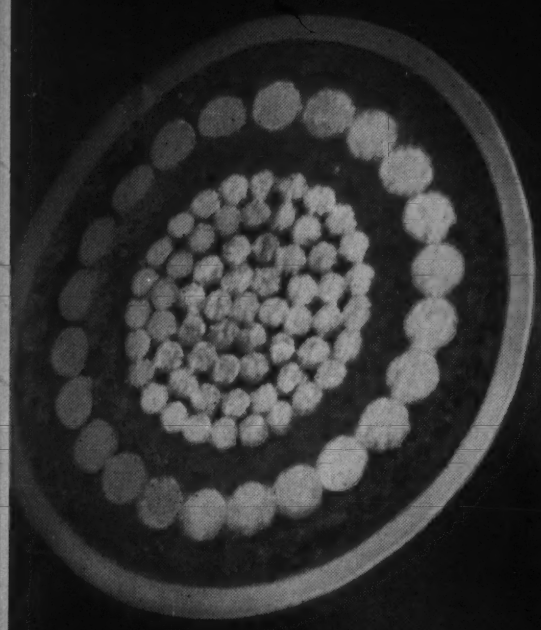

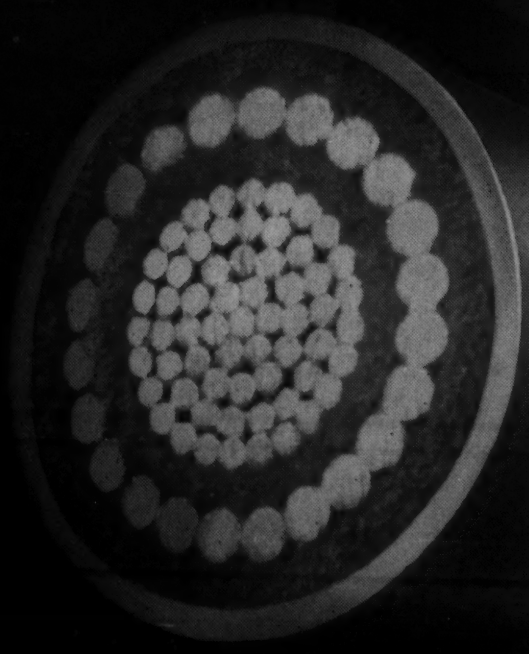

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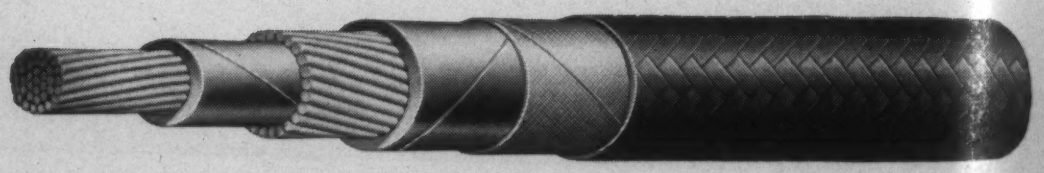

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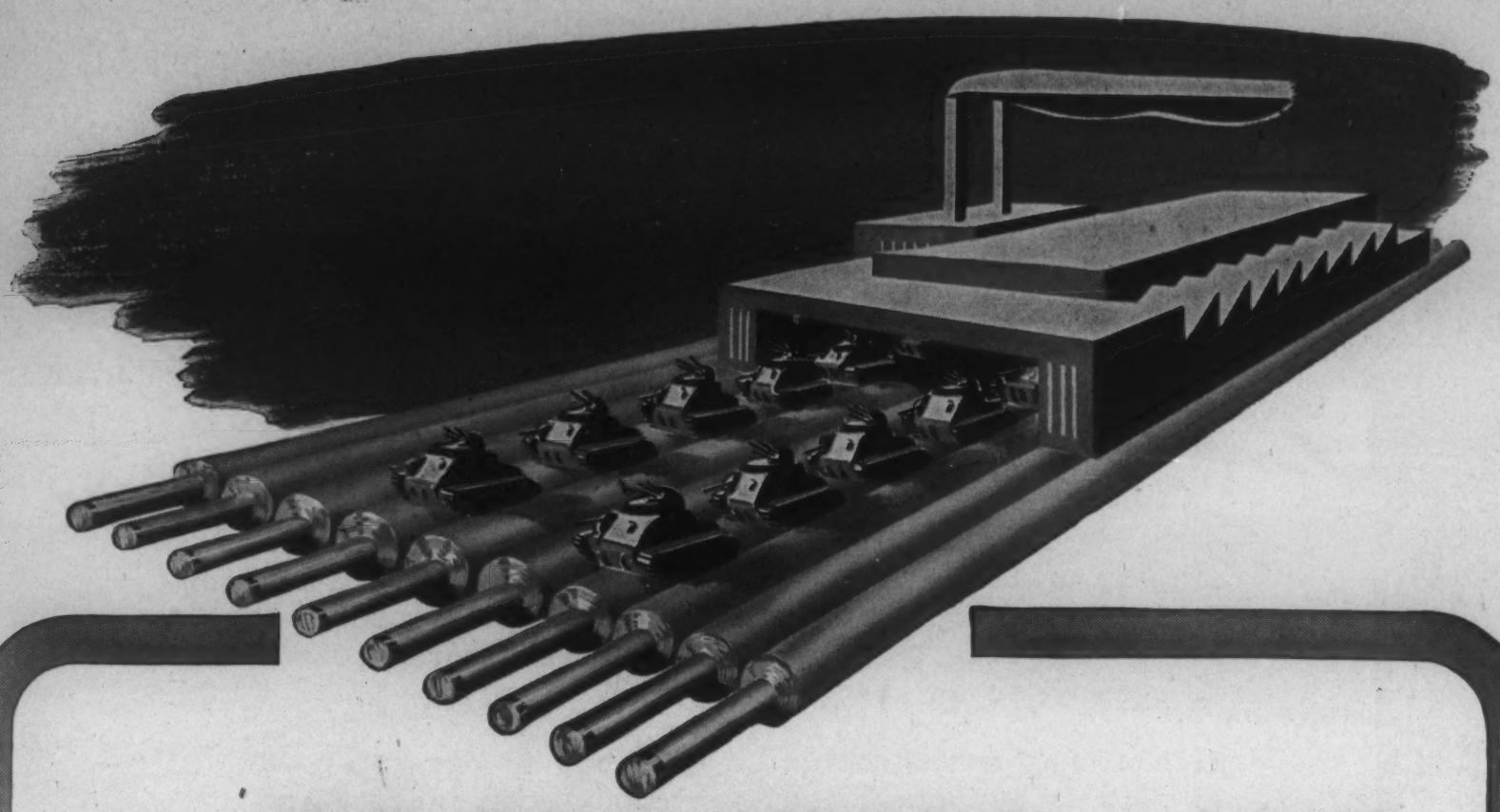

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How to Conserve Stainless Steel and Increase War Production!

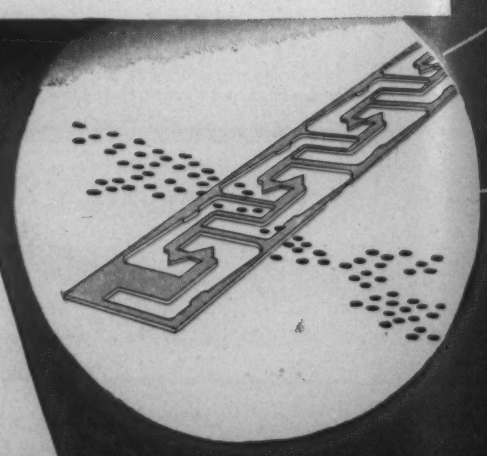
When you were turning out war equipment and parts in smaller numbers, Stainless Steel scrap losses in fabrication involved fewer pounds of vital metals. But now that output has leaped into mass production, scrap losses must be reduced to an absolute minimum.

With nickel and chromium so precious to our war needs, it is vitally important that you check your fabricating methods at every point. Waste is terrifically expensive in loss of time and strategic materials.

Helping to get the most out of every pound of Stainless Steel is a part of Carpenter's Wartime job. The knowledge and experience we have gained from pioneering the fabrication and use of Stainless Steels is now being offered to you. Let your Carpenter representative help you check your tools, dies and lubricants—to make sure your set-up is right for maximum production from a minimum of material. Meanwhile, here are specific suggestions to help you speed war production and conserve material. Be sure to check these points in your plant now! Time is short!

√Check your Scrap Losses

If you are blanking, forming or drawing parts from sheet, find out if using a narrow strip could eliminate slitting and reduce your scrap loss. One plant reported a 40% material saving by adopting strip to the specified width for the particular part. Jobs were laid out more economically, and time spent handling material was reduced. The accurate gauges and tolerances of Stainless Strip save wear on dies and reduce rejects.

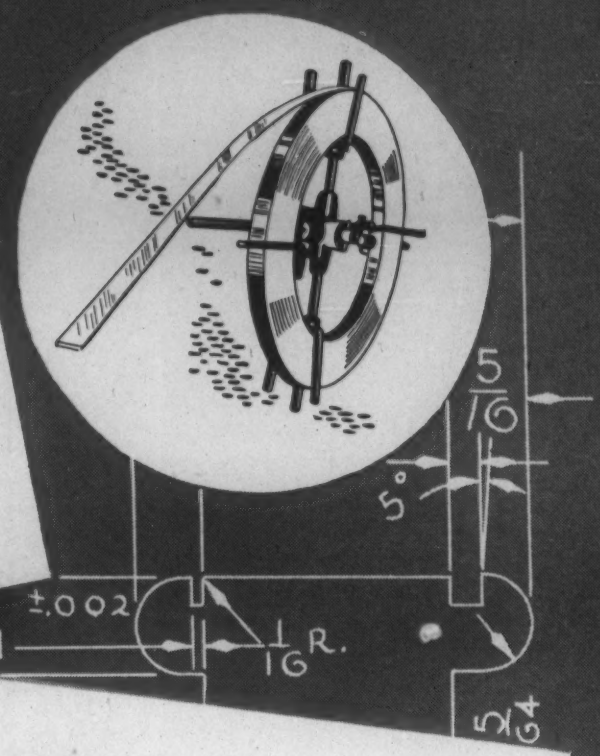


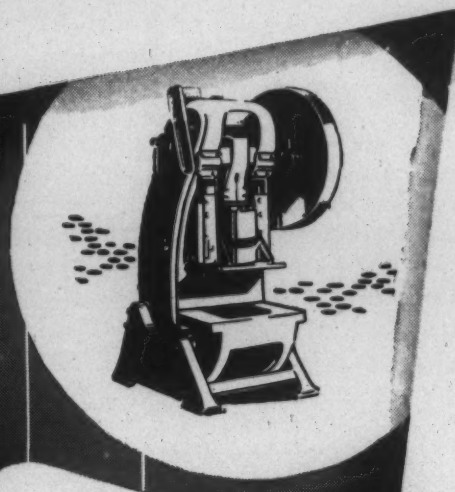
Carpenter

BRANCHES AT Chicago, Cleveland

✓Check your Physicals

Find out if you can take advantage of the natural strength of Stainless by using a lighter gauge strip. Often, an embossed rib can be used to add strength, allowing the use of lighter gauge stocks. Still another way to speed war production is to make sure that each order to your supplier is complete—from physical specifications to priority information.





✓Check your Fabricating Speeds

Here again, the blanking, forming or drawing of parts can often be speeded by using Stainless Strip. You get it in coils, and because of accurate gauge—uniform tolerance—it feeds into the press automatically. Only correct press speeds boost production. A quick check-up may even show you that slower press speeds will enable you to increase output, reduce rejects, and get longer tool life.

✓Check your Rejects

If your rejects are high, it's time to start checking all along the line. Material too much undersize can cause wrinkling in the die. Oversize material may explain galling and tearing. Check your tool layouts, die clearances and lubricants. And if your scrap pile continues to show a high percentage of rejected parts—it's time to call in an expert.

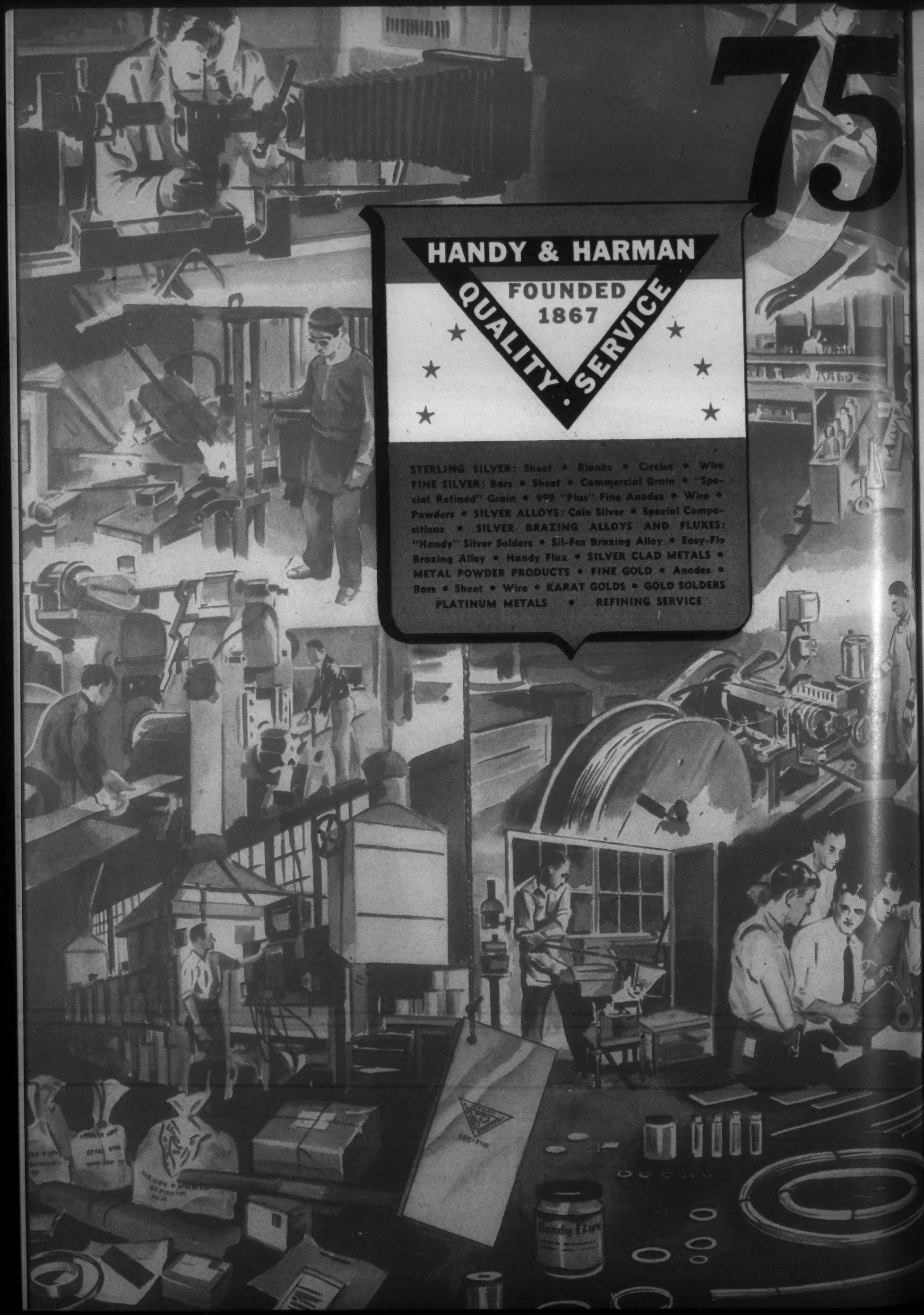
THE CARPENTER STEEL COMPANY, 135 Bern St., Reading, Pa.

STAINLESS STEELS

Detroit, Hartford, St. Louis, Indianapolis, New York, Philadelphia

more than corrosion resistance

The Carpenter Stainless Selector Slide Chart can give you quick answers to your questions on the grades of Stainless to meet your requirements. It shows the machining, heat and corrosion resisting properties of each analysis of Stainless Steel. A note on your business letterhead will bring you a Slide Chart—free to Stainless Steel users in the U. S. A.


75
HANDY & HARMAN
FOUNDED
1867
QUALITY · SERVICE
STERLING SILVER: Sheet • Blanks • Circles • Wire
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PLATINUM METALS • REFINING SERVICE

Years of looking and keeping ahead!

IN this period of world conflict and national crisis, the announcement of Handy & Harman's 75th anniversary carries with it a message of reassurance, a reminder that there have been other grave periods, bravely weathered. With America, Handy & Harman has endured difficult conditions, has grown and prospered in times of great business expansion. With America, Handy & Harman looks forward to the successful termination of the present conflict, and to the time when all our efforts can once more be devoted to work of lasting value.

Starting from a modest beginning in 1867, Handy & Harman has risen to a position of national prominence in the Arts and Industries. Its products are now rendering vitally important service in America's war production.

HANDY & HARMAN IN THE ARTS

At the turn of the century we foresaw the need for segregating and improving the fabrication of gold, silver and their alloys. Methods and machines were perfected, which raised the mass production of these metals to an exact science and assured uniform quality, gauge and working properties. Through the years, we have been supplying the bulk of the sterling silver and much of the karat gold needed by jewelry manufacturers and silversmiths.

Likewise, we developed silver solders and also advanced plating by providing silver anodes of exceptional fineness and purity.

Another contribution was the institution of a refining service for recovering precious metals from scrap, sweeps and waste and its elevation to the highest plane of accuracy and reliability — a service that soon became nation-wide.

For 60 years Handy & Harman has set the daily market price of silver which is accepted as the basis for buying and selling — a trust we zealously guard.

In the present crisis we are doing everything possible to provide users with the silver they need on a fair basis. There is a shortage and we have to ration our supply.

HANDY & HARMAN IN INDUSTRY

About 15 years ago fabrication of equipment and parts from thin gauge metal began to come into the industrial picture. We recognized the suitability of silver brazing alloys for this work because of their comparatively low flow points, free-flowing properties and the strength, ductility and corrosion-resistance of joints made with them. Extensive research resulted in the production and standardization of a range of compositions that met various requirements.

Seeking further, we developed the low temperature brazing alloys Sil-Fos and Easy-Flo which, with Handy Flux, have revolutionized metal joining in speed, reliability and economy. With amazing rapidity the use of these alloys spread through industry. Now they are doing thousands of jobs which are helping to speed up the making of planes, ships, tanks, guns, shells and other war equipment and their production is 100% for war work.

We have taken a leading part in developing other inaustrial uses of silver which are contributing, directly or indirectly, to further our war effort.

Today, as always, one of our most important contributions is the aid we give to users in applying our products and especially in solving brazing problems.

Our many customers, of course, have been a vital force in Handy & Harman's progress and achievements and to them we extend our deep appreciation. As we go forward, keeping alert to changing trends and yet holding fast to sound traditions, our consistent aim will always be to satisfy and hold the esteem of those we serve.

HANDY & HARMAN

General Offices — 82 Fulton St., New York, N. Y.

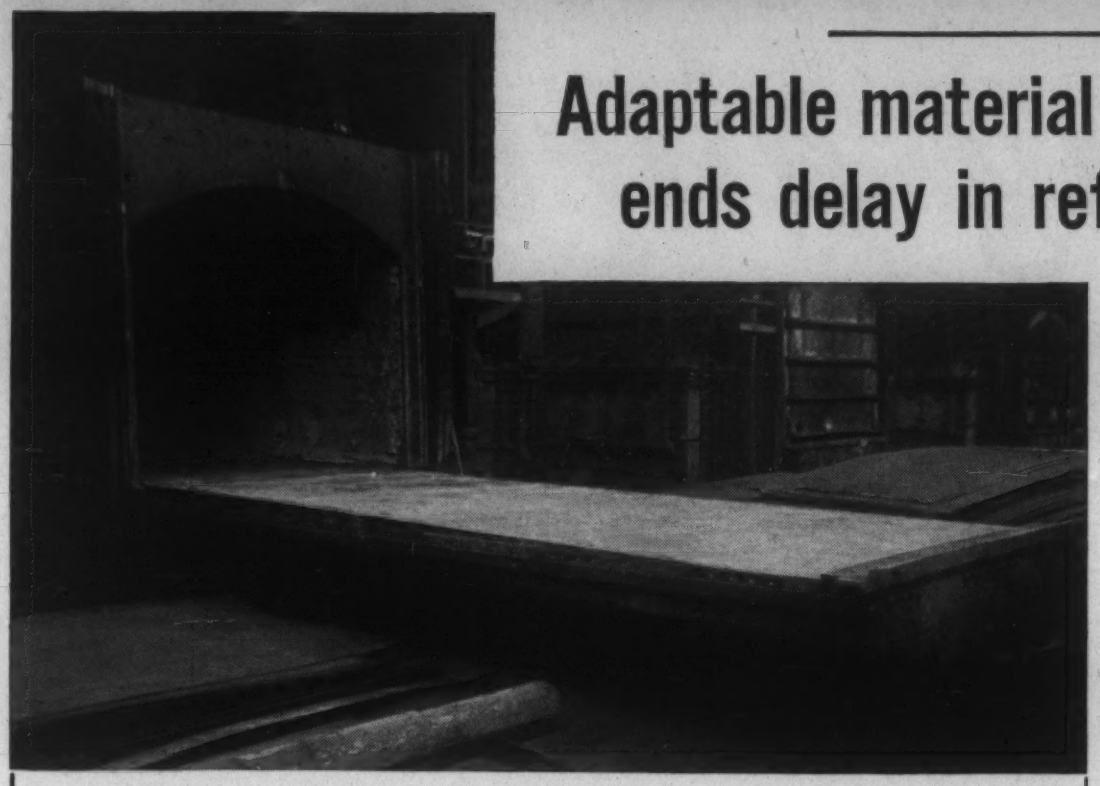
Principal Plant — Bridgeport, Conn.

Service Plants — New York, N. Y. — Providence, R. I.

Branch Office — Chicago, Ill. *In Canada* — Handy & Harman of Canada, Ltd., Toronto

FURNACE BUILDERS SAVE TIME BY USING REFRACTORY CONCRETE

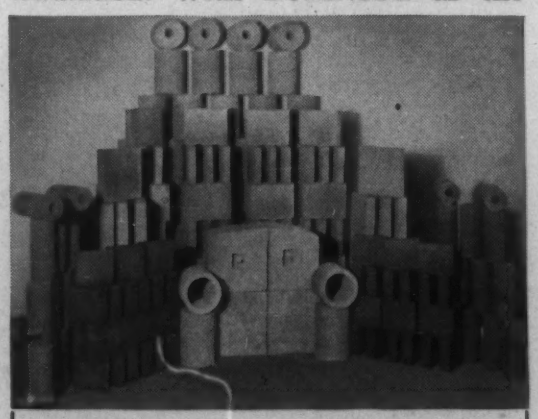
Adaptable material made with LUMNITE ends delay in refractory work . . .



● *An example of adaptability of Refractory Concrete is this annealing car top. It's a big top, 40 feet long by 12 feet wide. But, whether the top is small or large, Refractory Concrete can be made to fit. It's cast in place to suit the job.*

Save Money in 4 Ways with Refractory *Insulating* Concrete

By selecting the right aggregate you can have Refractory Concrete plus insulation. With LUMNITE as the



Another example of adaptability. *Refractory* Insulating *Concrete units good for 2000° F. Most of these shapes will go into laboratory furnaces to help American defense. The Universal Zonolite Insulation Company of Detroit is turning them out in quantity. Every one is made with LUMNITE!*

binder, a special, light-weight aggregate or insulating firebrick grog is used. Your savings result from:

1—Availability—no delay in construction.

2—Low initial cost of Refractory *Insulating* Concrete compared with other insulating refractories.

3—Adaptability—cast in place to fit the job.

4—Reduction of heat loss in operation.

Ready-to-use LUMNITE Insulating Castable Refractories are also available. As with other LUMNITE castables, they are shipped in dry form, mixed with water on the job and cast in place.

For Convenience, Use Castable Refractories Made with LUMNITE

Factory-prepared LUMNITE Castable Refractories are ready to use without the addition of anything except water. When mixed with water, they may be cast in place or molded into precast units in the same manner as all Refractory Concrete.

These ready-to-use LUMNITE Castable Refractories are accurately proportioned mixtures of LUMNITE and properly sized refractory materials. They can be obtained from refractories manufacturers and distributors—without delay.

Easily Available now . . .

Refractory Concrete is made with LUMNITE and refractory aggregates. LUMNITE is sold by building supply dealers throughout the United States and in Canada.

The aggregates—refractory materials crushed and sized for making concrete—can be prepared in your plant or obtained from manufacturers and dealers. A number of light-weight aggregates for Refractory *Insulating* Concrete are also available at low cost.

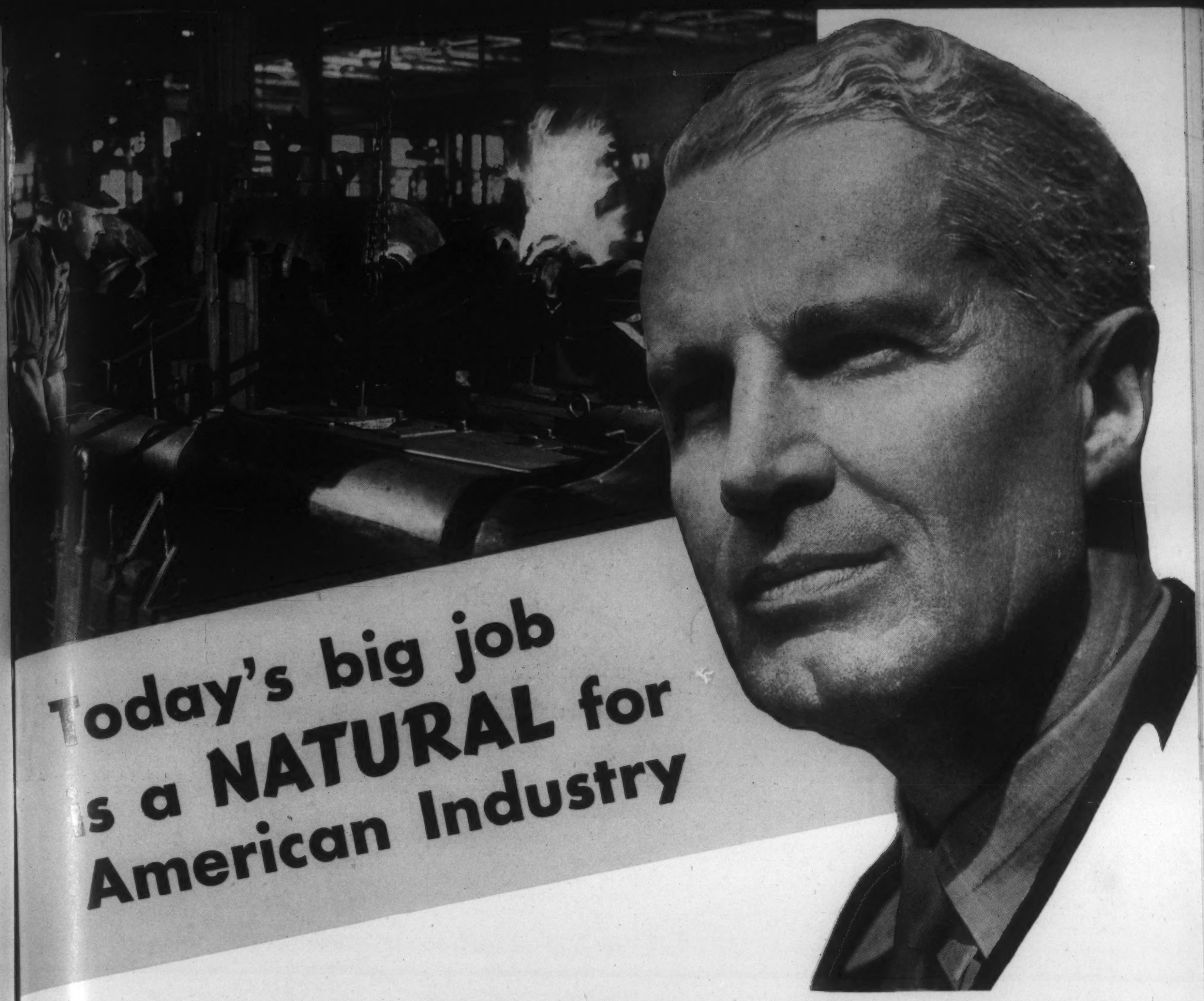
Adaptability of Refractory Concrete saves time

Molded in place, formed to fit the skewback, arch, port or whatever complicated section you need, Refractory Concrete eliminates cutting, does away with special shapes, leaves no waste. It is formed to fit your job. You can even change your mind at the last minute, change thickness of wall or design of arch—without changing material requisitions.

HOW CAN YOU USE IT?

Find out about using Refractory Concrete to meet *your* requirements. Tell us what you need. Low temperature, high temperature, insulation? Write The Atlas LUMNITE Cement Company (United States Steel Corporation Subsidiary), Dept. M., Chrysler Building, New York City.

LUMNITE FOR REFRACTORY CONCRETE



Today's big job is a NATURAL for American Industry

New products, new materials, new processes . . . a challenge to the inventiveness and alertness of American Industry. A challenge that's being met in the inevitable way—by a combination of the applied research and resourcefulness that put American Industry out in front.

Here at the "Brass Company" we've changed over from normal peacetime operations to the production of more urgently needed materials of war. It has been done with the utmost speed and confidence, because we did it before—and knew how.

To meet the requirements of our ever-expanding armament program, we have converted, expanded, changed normal procedures and shifted emphasis all along the line.

ANACONDA from mine to consumer

THE AMERICAN BRASS COMPANY

General Offices: Waterbury, Connecticut

But here's the point . . .

WE WANT TO HELP OTHERS WHO ARE DOING THE SAME THING

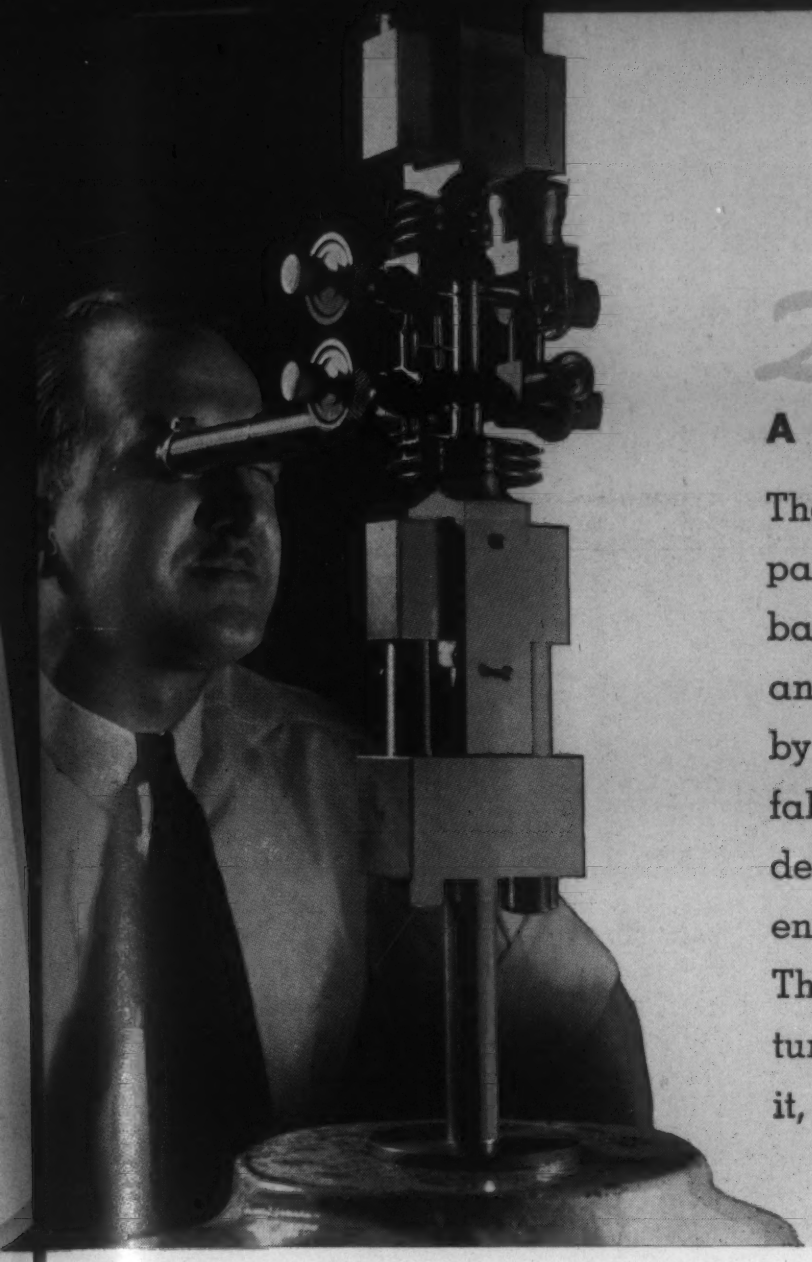
Anaconda Copper & Copper Alloys

If it's Copper, Brass or Bronze for war work—we can help you in these *Three Ways*

To those metal working plants engaged in the manufacture of a new product, perhaps by unfamiliar procedures, we believe we can be of assistance by providing helpful suggestions for working copper, brass, bronze and the high-strength copper-base metals such as the copper-silicon alloys. This assistance is threefold:

1 A SPECIAL ENGINEERING SERVICE

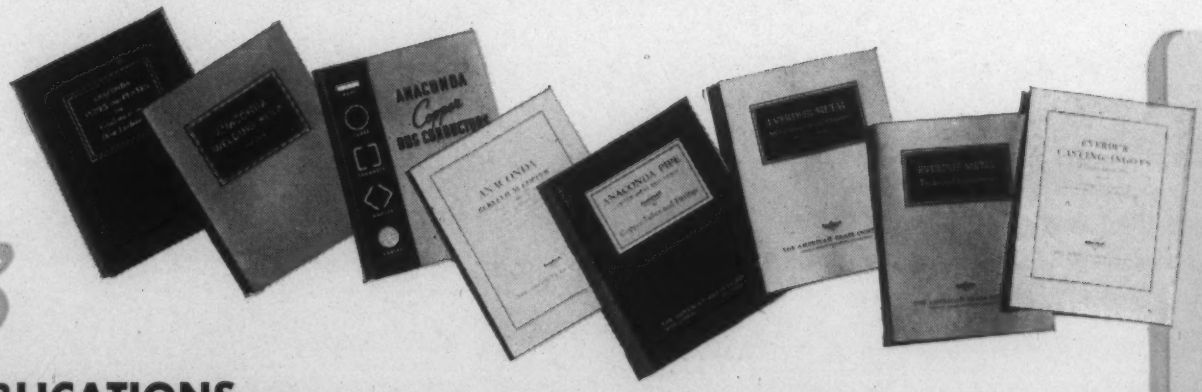
Our Metallurgists and Engineers are prepared to cooperate in finding the correct solution for special metal problems. Their practical experience in many branches of the metal industry during times of both war and peace enables them to effect many production short cuts by determining the one best metal for a specific application, and the correct procedure for its fabrication. The "custom made" alloy you need may be one regularly produced by us. Your inquiries will receive the close attention of men who are doing this work every day—in every branch of the metal working field where copper and its alloys are being used.



2

A LABORATORY YOU CAN CALL YOUR OWN

The Technical Department of The American Brass Company has acquired a wealth of metallurgical experience, based principally on the fact that the physical properties and corrosion resistance of copper alloys can be varied by controlled adjustment of composition and methods of fabrication. In our own mills, the control procedure, once determined, becomes routine, thereby assuring consistently uniform characteristics in the metals we produce. This technical information, representing more than a century of experience, and the laboratories responsible for it, are at your service in fitting the metal to the need.



3

PUBLICATIONS— FROM OUR TECHNICAL DEPARTMENT TO YOURS

Available also to you, without cost, is a list of up-to-the-minute publications on copper and copper alloys. They are literally packed with useful, technical information which your engineers will find extremely helpful: Applications, compositions, general physical constants, physical properties; fabricating procedures; oxy-acetylene and electric welding of copper and copper-alloys; weight tables and conversion factors; flow tables for pipe and tube; operating characteristics of copper bus conductors; etc., etc. Some of these Anaconda Publications are listed here. They may give you the information you need.

ANACONDA PUBLICATIONS

B-31	Anaconda Metals in the Aircraft Industry
B-1	Pipe, Copper Tubes and Fittings
B-28	Anaconda Copper and Copper Alloys
B-2	Tubes and Plates for Condensers and Heat Exchangers
B-9	Hot Pressed Parts and Pressure Die Castings
B-21	Anaconda Beryllium Copper
B-13	Copper and Copper-Alloy Welding Rods
B-14	Free Cutting Brass Rods
B-22	Anaconda Electrical Conduit
B-16	Tobin Bronze
C-24	Copper Tubes for Industrial Applications
C-25	Anaconda Copper Bus Conductors
E-1	Everdur Metal Casting Ingots
E-5	Everdur Metal Applications, Physical Properties and Constants
E-6	Everdur Metal Bolts, Screws and Accessories
E-9	Copper and Everdur Fabricated Fittings
E-13	Everdur Metal Tanks and Equipment

Requests for Anaconda Publications should be sent to:

The American Brass Company
General Offices: Waterbury, Conn.

Made by The American Brass Company

Copper is needed EVERYWHERE

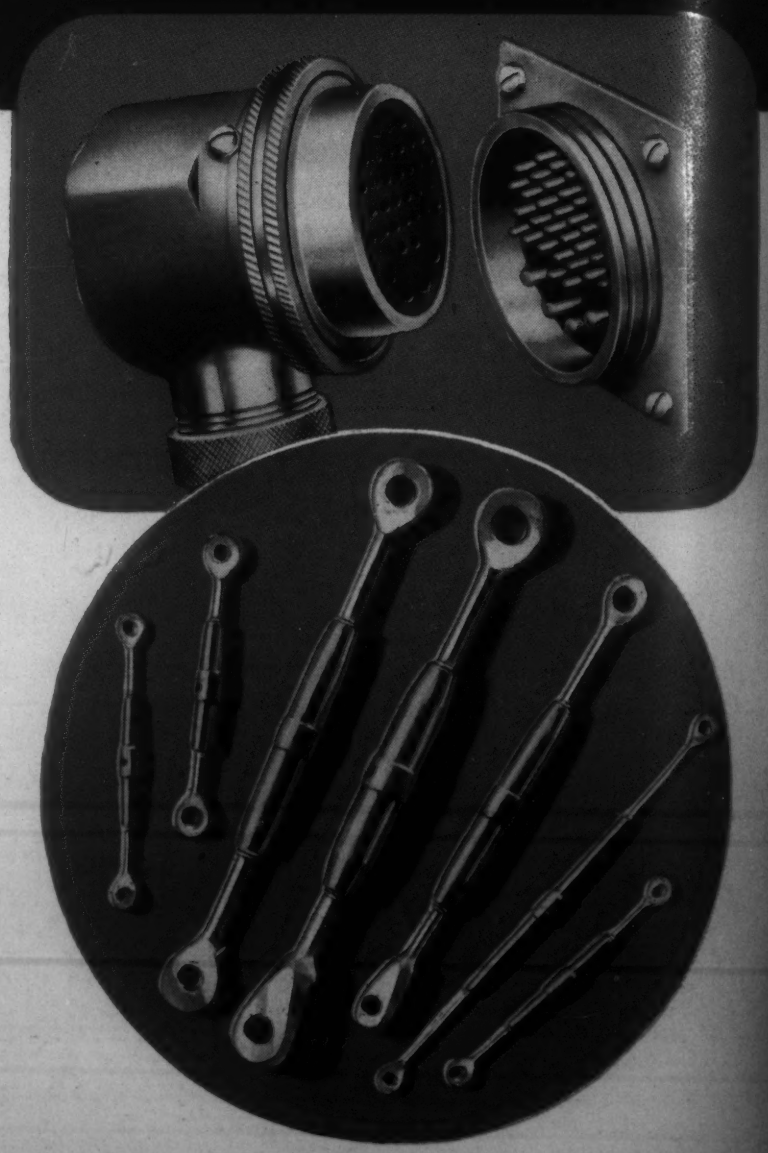
The Nation's war needs for copper, brass and bronze are great. The ever-quickening tempo of armament production in every field means a corresponding step-up in the demand for these dependable, workable, corrosion-resistant metals. A few typical uses in the aircraft industry are illustrated below . . .

For Instance:

The building of Curtis Pursuit Ships and Army Cargo Transports consumes large quantities of Anaconda Metals; brass rod and strip, copper tubes, beryllium copper—also *Everdur tubes for hydraulic lines. The Curtis Kittyhawk illustrated (one of the P-40 Series) is firing copper-alloy jacketed cartridges from all six wing guns.

Only a contact pin—yet, the Cannon Electrical Development Company, manufacturers of multi-contact electrical cable connectors, uses hundreds of thousands of pounds of Anaconda Brass Rod to keep pace with the electrical plug requirements of our rapidly expanding aircraft industry.

Tons of specially-treated *Tobin Bronze are used by the Aero Supply & Mfg. Co., Inc., in producing the barrels of aeronautical turnbuckles because this American Brass Company Alloy machines and threads readily, and has the required physical properties to meet U. S. Army Specifications.



THE AMERICAN BRASS COMPANY

General Offices: Waterbury, Connecticut

Offices and Agencies in Principal Cities

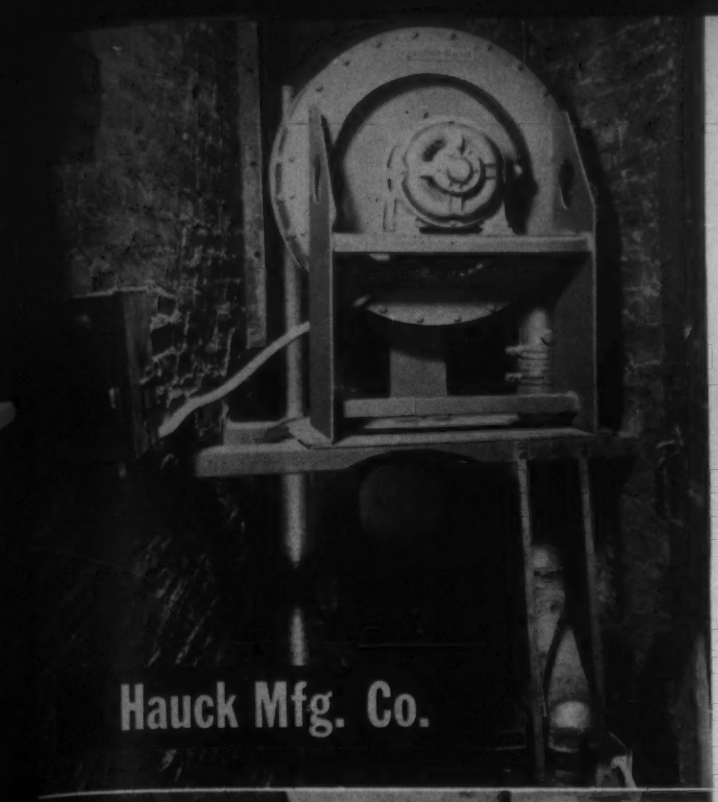
Subsidiary of Anaconda Copper Mining Company

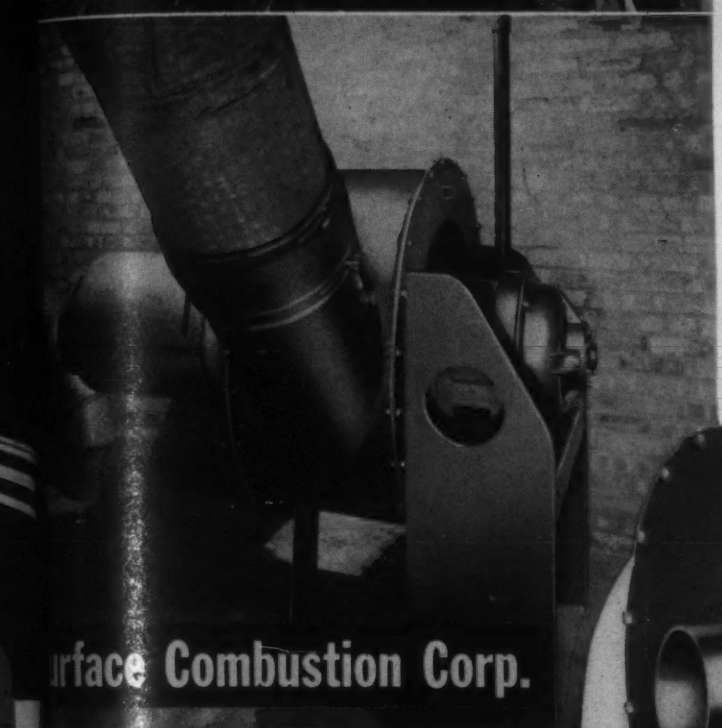
In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

*Trade-Mark Reg. U. S. Pat. Off.

ANACONDA from mi[illegible] to consumer

Anaconda Copper & Copper Alloys





Specify

TYPE "G"

MOTORBLOWER

FOR

OIL and GAS FURNACES

Every Type "G" MOTORBLOWER shown on this page is playing a direct part in the nation's war effort—they are representative of the hundreds of similar units now in day-and-night service where oil- and gas-burning furnaces are used.

Ask your furnace or burner equipment maker to select the proper size Ingersoll-Rand Type "G" for your job. This will assure you of a dependable, economical blower for your combustion air supply.

Type "G" MOTORBLOWERS are built in sizes from 2 to 30 hp; pressures range from ½ to 2¼ lb; capacities from 100 to 4500 cfm. Bulletin 2671-A will be sent on request.

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HOW TO SAVE TIME IN GETTING STEEL

HERE ARE TWO SUGGESTIONS. Follow them and you'll save time—the most important thing in the world today—in getting the steel you need for *Production for Victory.*

1. Keep up to date on Governmental regulations and revisions—and follow procedure as established by the War Production Board.

2. Be sure to give your steel supplier *COMPLETE* information on your inquiries or orders. Always include:

★ Government contract number and specification (department, number, date) . . . War Production Board allocation order . . . preference rating certificate or endorsement . . . Army-Navy Munitions Board code number.

ALLOY and CARBON STEELS • STAINLESS STEEL • PLATES • TIN PLATE • NUTS, BOLTS • RIVETS • NAILS • PIG IRON
BARS and SHAPES • STRIP • SHEETS • PIPE and TUBING • FARM FENCE • WIRE • FABRICATED STEEL PRODUCTS

★ Complete details on chemistry, physical properties and processing requirements (heat treatment, hardenability, etc.)

★ Full information on use of the steel. Be specific. Do not merely say "gears," but "a certain type of gear for a certain type and size of tank" or whatever the application may be. Sometimes several grades of steel may be suitable, but one may be more quickly available.

★ Make certain that all other necessary information is furnished—such as finishing required at the mill, nature of your first operation (for instance, is it cold shearing, saw cutting or other?), code painting specifications, shipping instructions, etc. The absence or incorrectness of these details may result in loss of time which cannot be recovered.

Complete information at the time the inquiry is made or the order placed will speed up clearance through Governmental agencies. It will speed up production of the steel and delivery to you. And, incidentally, it will save you the cost of extra correspondence, telegrams and 'phone calls.

We at Republic are working closely with Governmental agencies and customers. We're doing everything possible to help clear vital orders through to the mills so that the steel can be processed in the shortest possible time.

Won't you help us to help you speed *Production for Victory* by furnishing complete information when you need steel?

REPUBLIC STEEL
PRODUCTION FOR VICTORY

REPUBLIC STEEL CORPORATION

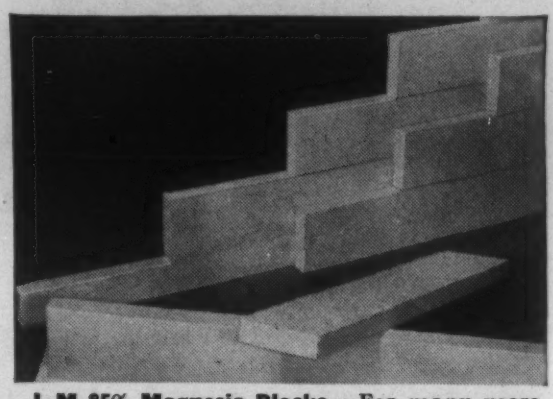
Alloy Steel Division Sales Offices: Massillon, Ohio • General Offices: Cleveland, Ohio

Berger Manufacturing Division • Culvert Division • Niles Steel Products Division
Steel and Tubes Division • Union Drawn Steel Division • Truscon Steel Company
• • *Export Department:* Chrysler Building, New York, New York • •

For greater efficiency and maximum fuel savings in iron and steel industry service...

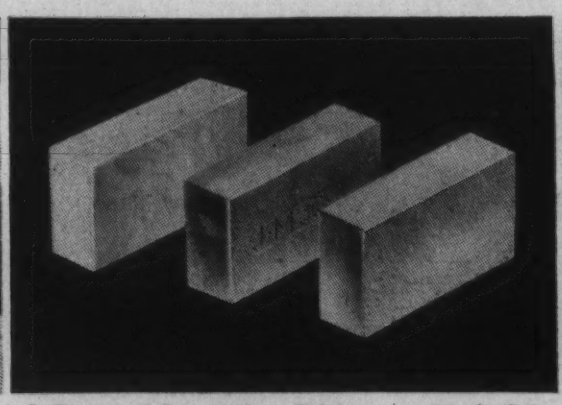
Johns-Manville Insulations

Superex Blocks—The outstanding block insulation for temperatures to 1900° F. Combines high heat resistance with low thermal conductivity. Standard sizes 3″ x 18″, 6″ x 36″ and 12″ x 36″; from 1″ to 4″ thick.

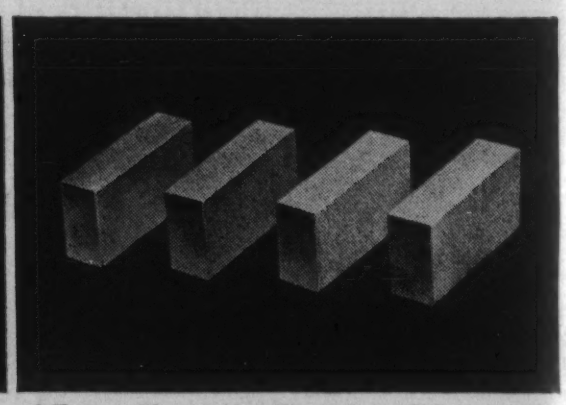


J-M 85% Magnesia Blocks—For many years the most widely used block insulation for temperatures to 600° F. Highly efficient and durable. Standard sizes 3″ x 18″, 6″ x 36″ and 12″ x 36″; from 1″ to 4″ thick.

J-M Superex Combination—An inner layer of Superex and an outer layer of J-M 85% Magnesia. Combines high heat resistance and exceptional insulating efficiency. Available in both block and pipe-covering forms.

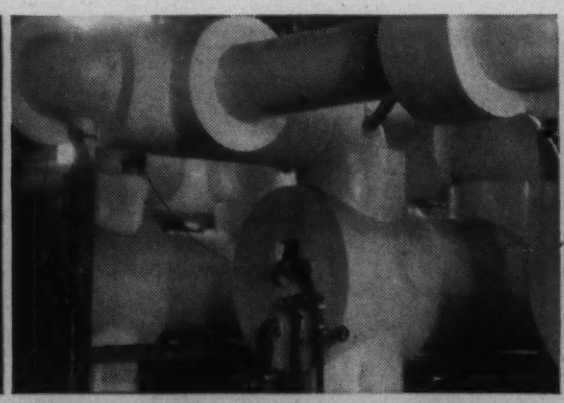


3 Types of Insulating Brick . . . Sil-O-Cel Natural Brick (1600° F.); Sil-O-Cel C-22 Brick (2000° F.); Sil-O-Cel Super Brick (2500° F.). Available in all standard 9″ shapes of the 2½″ and 3″ series.

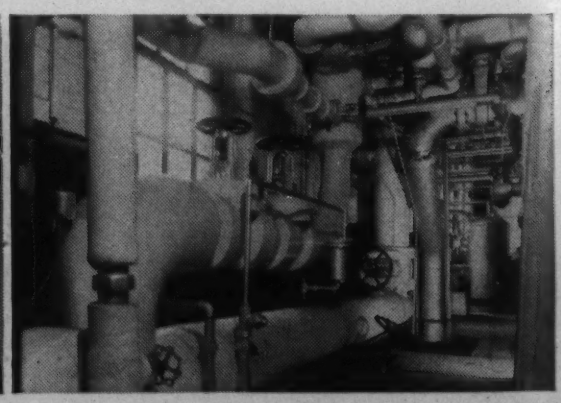


4 Types of Insulating Fire Brick—JM-16 (1600° F.); JM-20 (2000° F.); JM-23 (2300° F.); JM-26 (2600° F.). Combine light weight, low conductivity, low cost. All standard 9″ shapes of the 2½″ and 3″ series.

Sil-O-Cel C-3 Concrete—Cast on the job from Sil-O-Cel C-3 aggregate and cement. Sets up into a durable semi-refractory insulating concrete for use up to 1800° F. 28 lbs. required per cu. ft. Shipped in 100-lb. bags.



J-M 85% Magnesia Pipe Covering—Long recognized as the standard pipe insulation for temperatures up to 600° F. Highly efficient, durable, long lasting. Furnished in 3-ft. lengths in thicknesses up to 3″.



Asbesto-Sponge Felted Pipe Insulation—Especially suited to steel mill service because of its unusual durability and resistance to abuse. For temperatures to 700° F. Furnished in 3-ft. lengths in thicknesses up to 3″.

JOHNS-MANVILLE JM PRODUCTS

For details on these materials, and on the complete J-M Insulation line, write for catalog GI-6A. Johns-Manville, 22 East 40th Street, New York, N. Y.

Johns-Manville INDUSTRIAL INSULATIONS

For every temperature . . . for every service

DREVER

EXPERIENCE POINTS TO

FURNACES

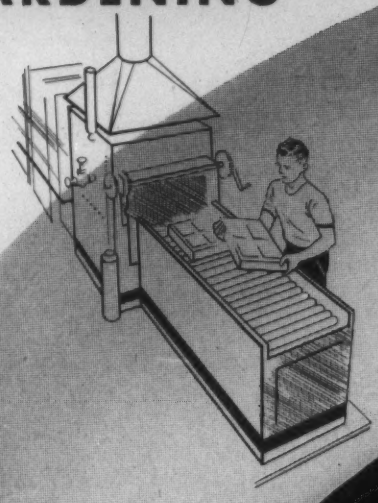
THE DREVER COMPANY • 750 E. VENANGO ST., PHILADELPHIA, PA.

SAVE VITAL

Production Time

WITH ENDOGAS

CLEAN-HARDENING

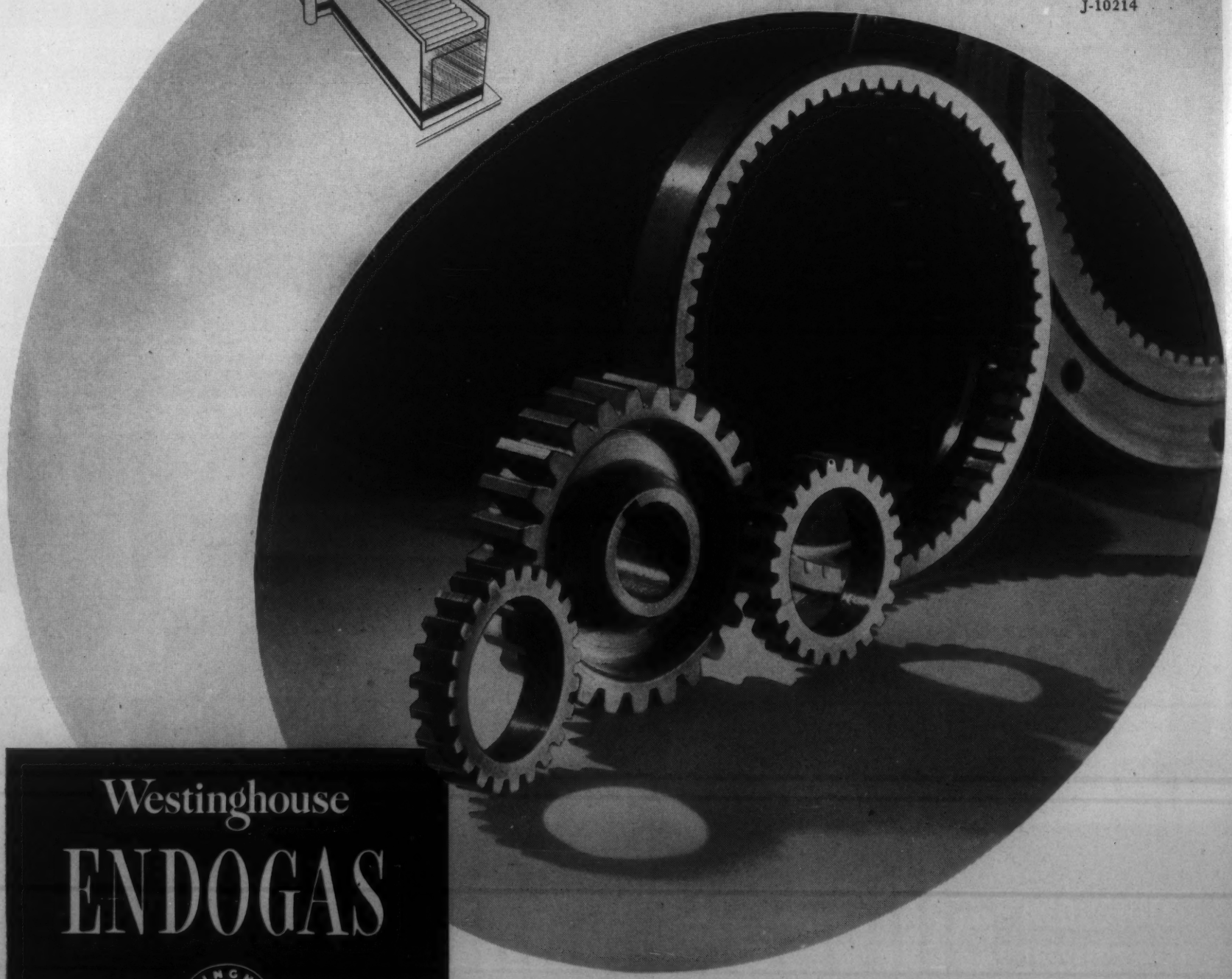


Any S. A. E. steel hardened without "Decarb"

Decarburizing, oxidation and warpage resulting from ordinary heat-treating take time—COSTLY TIME—to correct. Yet descaling, resurfacing and correction of distortion are today largely unnecessary. Endogas—a Westinghouse development—eliminates need for these time-consuming operations, because it permits hardening of all S.A.E. steels without decarburization—even stubborn S.A.E. 1095.

If your steel heat-treating processes at present involve extra operations for cleaning, it will pay you to investigate how inexpensively the Westinghouse Endogas way can eliminate them. No costly dryers or CO_2 removal equipment—Endogas is obtained by starting with either natural or manufactured city gas as a base. Consult your Westinghouse representative for details, or write Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., Dept. 7-N.

J-10214



Westinghouse

ENDOGAS

WESTINGHOUSE

COMPLETE HEAT-TREATING EQUIPMENT

Pennsalt Cleaner is helping speed the production of Machine Gun barrels in this plant, with fast, efficient stripping and cleaning.

Prominent Manufacturer of Tools, Gauges, Machines and Specialty Parts reduces rejects—increases production—cuts costs

with PENNSALT CLEANERS

This manufacturer of precision parts—many for guns and aircraft—requires metal cleaners with extraordinarily high standards of performance. The extremely close tolerances to which the parts are held—plus the imperative demand for maximum output made the choice of cleaner important.

Pennsalt Cleaners meet the rigid requirements of this plant with notable success. The operations were:—The unusually thorough and uniform removal of oil and buffing compound from steel and zinc necessary before chrome plating . . . the stripping of hard chrome plate from steel, with the positive assurance of no injury to the steel surface . . . and the heavy-duty cleaning of steel prior to cadmium plating.

The illustration above shows machine gun barrels being cleaned. Pennsalt Cleaner is used to clean new barrels before chrome plating and, in reconditioning barrels, to strip chrome from the steel before replating.

In all their exacting duties Pennsalt Cleaners have an outstanding record. Here it is:—*Increased production because of fewer rejects* . . . a reduction in cleaning costs . . . smoother plating surfaces and more efficient stripping, through better conductivity.

A test in your plant under your own conditions will show you why Pennsalt Cleaners have won the confidence and endorsement of so many manufacturers in a wide range of metal cleaning operations. An experienced technical staff is at your service for information or advice, without obligation. Or write fully to our Pennsalt Cleaner Division, Dept. MA.

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Manufacturers' Literature

YOURS FOR THE ASKING

1. Ferrous Metals

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Alloyed Irons for Temperature Resistance. Sterling Alloys, Inc. (1-150)

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Basic Open-Hearth Alloy Steel. Andrews Steel Co. (1-166)

Low Alloy Steels. Great Lake Steel Corp. (1-171)

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Mo-Max High Speed Steels. Cleveland Twist Drill Co. (1-11)

Tungsten-Molybdenum High-Speed Steel. Latrobe Electric Steel Co. (1-175)

STAINLESS STEELS

Stainless and Heat-Resisting Steels. Republic Steel Corp. This is a 28-page catalog deluxe, in step with the glamour product described. "Through the Looking Glass into Enduro Wonderland" introduces the subject. It is the "magic metal of ten thousand uses," many of which are listed. (1-178)

Stainless Clad Steel ("Pluramelt"). Allegheny Ludlum Steel Co. (1-161)

Stainless Steel Data Chart. Apollo Metal Works. (1-174)

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Cold Header Die Steel. Jessop Steel Co. (1-141)

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Electrolytic and Sponge Iron Powder. Plastic Metals, Inc. (1-167)

Steel Stock List. Jos. T. Ryerson & Son, Inc. (1-169)

2. Non-Ferrous Metals

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Alternates for Tin Bronze. Ampco Metal, Inc. This single-page leaflet suggests that silicon bronze is a good substitute for tin bronze. There is a table of physical properties of bronzes and alternates. (2-177)

Copper Alloys in the Aircraft Industries. American Brass Co. (2-158)

High Strength Bronze. American Manganese Bronze Co. (2-172)

Forgeable Bearing Metal. Mueller Brass Co. (2-165)

Phosphor Bronze. Phosphor Bronze Smelting Co. (2-100)

Brass and Bronze. Titan Metal Manufacturing Co. (2-102)

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Magnesium Alloys. American Magnesium Corp. (2-57)

Magnesium Alloys. Dow Chemical Co. (2-104)

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Properties of Lead-Bearing Alloys. American Smelting & Refining Co., Federated Metals Div. (2-166)

Low Temperature Melting Alloys, Cerro de Pasco Copper Corp. (2-84)

SPECIAL METALS

Alloy Powders. Ekstrand & Tholand, Inc. (2-93)

Uses of Indium. Indium Corporation of America. (2-124)

Zinc and the War Program. New Jersey Zinc Co. (2-156)

3. Engineering Design

ALLOY CASTINGS

Alloy Furnace Parts. American Manganese Steel Div., Am. Brake Shoe & Fdry. Co. Sixteen pages are profusely illustrated, such as carburizing, annealing and heat-treating boxes; cyanide, lead and other liquid containers; retorts and muffles, buggies and trays. (3-216)

Castings Equipment Booklet. American Brake Shoe & Foundry Co. (3-193)

Heat Resisting Alloy. Chicago Steel Foundry Co. (3-19)

Corrosive Handling Equipment. Duraloy Company. (3-183)

Corrosion and Heat Resistant Castings. Michiana Products Corp. (3-91)

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Acid-Resistant Castings. Duriron Co., Inc. Durimet, a special austenitic nickel-chromium stainless steel claimed to be well balanced metallurgically, is discussed. It is highly resistant to sulphuric acid. (3-214)

Electric Furnace Iron Castings. Belle City Malleable Iron Co. (3-167)

Heavy-Duty Bronze Castings. Cramp Brass & Iron Foundries Div. (3-83)

Ductile Iron Castings. Ferrous Metals Corp. (3-57)

Bronze Castings. Frontier Bronze Co. (3-195)

Data on Brass and Bronze Castings. Hammond Brass Works. (3-194)

High Strength Castings in Defense Work. Meehanite Research Institute. (3-160)

Stainless Castings. Cooper Alloy Foundry Co. (3-9)

Vanadium in Cast Steels. Vanadium Corp. of America. (3-196)

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Saving with Die Castings. Doehler Die Casting Co. (3-197)

Aluminum Die Casting. Madison-Kipp Corp. (3-156)

FORGINGS

Pressed and Forged Products. Lenape Hydraulic Pressing & Forging Co. This 34-page catalog lists sizes and specifications of welding necks, nozzles, manhole saddles and fittings and specialties for a variety of industries. (3-211)

Drop Forging. Drop Forging Association. (3-174)

METAL PARTS

Bearing Bronze. Johnson Bronze Co. Universal Bronze is described as usable from end to end with no waste or scrap. Complete machining is claimed—inside diameter,

outside diameter and ends. There are over 350 stock sizes. (3-215)

Fittings for Weld-Type Construction. Bonney Forge & Tool Works. (3-199)

Oil-Retaining Bronze Bearings. Bound Brook Oil-Less Bearing Co. (3-206)

Thermostat Metals. General Plate Div., Metals & Controls Corp. (3-181)

Electrical Contacts. Gibson Electric Co. (3-76)

Self-Lubricating Bearings. Neveroil Bearing Co. (3-80)

Wear Resistant Precious Metal Parts. Permo Products Corp. (3-65)

Ball Bearing. SKF Industries, Inc.; Atlas Ball Division. (3-200)

Fittings and Flanges. Taylor Forge & Pipe Works. (3-88)

Thermostat Metals and Electric Contacts. H. A. Wilson Co. (3-70)

NON-METALLICS

Non-metallic Gears. General Electric Co. Photographs are unusually striking and many tables give precise facts. Gear materials are of two types, Fabroil and Textolite. (3-213)

Negative Temperature Coefficient Resistance Material. Keystone Carbon Co., Inc. Four practical applications, including the compensation of positive resistance changes in a circuit due to temperature variations. (3-217)

Plastics Review. Bakelite Corporation. (3-153)

Non-Metallic Materials. Continental Diamond Fibre Co. (3-129)

Plastics in Product Design. Durez Plastics & Chemicals, Inc. (3-93)

Plastic Data Book. Formica Insulation Co. (3-210)

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Plastic Products. Monsanto Chemical Co., Plastics Division. (3-150)

Corrosion Resistant Linings. National Carbon Co. (3-175)

Colloidal Graphite. National Graphite Co., Inc. (3-209)

Fibre Products in Design. Spaulding Fibre Co., Inc. (3-130)

Acid-Proof Piping and Fittings. U. S. Stoneware Co. (3-201)

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Metal Powder Facing. General Metals Powder Co. (3-188)

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Brass Fittings and Tubing. Imperial Brass Manufacturing Co. (3-149)

Decarburization on Heat Treated Aircraft Tubing. Summerill Tubing Co. (3-185)

Fine Small Tubing. Superior Tube Co. (3-133)

OTHER METAL-FORMS

Pre-Finished Plated Metals. American Nickeloid Co. This is an unusual and attractive wall chart, ready to hang, showing actual samples in pockets, of 6 metals plated with chromium, copper, brass and nickel. One purpose is to conserve strategic materials. (3-218)

Wire Conveyor Belts. Cambridge Wire Cloth Co. (3-141)

Fabricated Metal Products. Falstrom Company. (3-198)

4. Melting • Refining • Casting

ALLOYING AGENTS

Graphite Briquettes. U. S. Graphite Co. According to this leaflet, the briquettes are charged in the cupola to raise carbon content. The weight is 3¾ lbs. each, and are of Mexican graphite and a fluxing bond. (4-112)

Exothermic Alloying Agent. Chromium Mining & Smelting Corp., Ltd. (4-47)

Ferro-Titanium and Other Alloys. Titanium Alloy Manufacturing Co. (4-56)

AUXILIARIES

Core Coat. Foundry Services, Inc. Literature describes a product that forms a protective coating for cores, preventing metal from burning into the core and forming a rough skin on the casting. It can be used with ferrous and non-ferrous metals. (4-104)

Foundry Sand Control. Great Lakes Foundry Sand Co. Written by an outstanding authority, this 54-page book treats of the practical characteristics of foundry sand. Much information never published before. (4-106)

Molding Sand Binder. Hercules Powder Co. Reprint (40 pages) of a paper on the effect of resin binder on molding sands, presented before American Foundrymens' Association by Emile Pragoff, Jr. and C. P. Albus. (4-103)

Mold and Core Wash. Refractory Mica Products, Inc. Micawash, described in this bulletin, provides a smooth skin on cores and molds in ferrous and non-ferrous foundries. Cores can be shaken out without difficulty. (4-107)

Universal Cut-Off Machine. Tabor Mfg. Co. This leaflet claims savings in cutting time in removing gates and risers from castings. Flexibility for extremely large and heavy work is claimed. (4-109)

Moisture Removal From Blast Furnace Air. Carrier Corporation. (4-89)

Centrifugal Casting and Equipment. Centrifugal Casting Machine Co. (4-83)

Foundry Products. Dayton Oil Company (4-100)

Reclaiming Scrap Metal. Dreisbach Engineering Corp. (4-63)

Liquid Core Binders. International Paper Co. (4-97)

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Desulphurizing Agent. Mathieson Alkali Works, Inc. The subject of this brief bulletin is "Continuous Refining and Desulphurizing with Purite in Teapot Mixer Ladles." Purite insures a clean quiet pouring metal of uniform analysis, with lower losses, increased strength and improved machinability, it is claimed. (4-111)

Deoxidizers for Nickel Silver Alloys. Niagara Falls Smelting & Refining Corp. (4-88)

MELTING FURNACES AND PARTS

Laboratory Crucible Furnace. Campbell-Hausfeld Co. The furnace described melts small quantities of high temperature alloy metal in a hurry and at low cost. (4-105)

Foundry Furnaces. Crucible Furnace Co. The maker claims the Walker-York Furnace retains the good qualities of the pit furnace but surpasses in performance and quality. The slogan is: "Avoid Sick Metal." (4-110)

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In this Manufacturers' Literature INDEX, new bulletins are given complete reviews, and previously described older bulletins are merely listed in their proper places.

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Regenerative Furnace Control. Morgan Construction Co. The Isley system of regenerative furnace control, applicable to steel mill furnaces, is described. Maker claims 50% more regenerative capacity in furnace system. (4-102)

Induction Furnaces for Aluminum Alloys. Ajax Engineering Corp. (4-95)

Electric Furnaces. American Bridge Co. (4-82)

Cutting Crucible Costs. Crucible Manufacturing Co. (4-36)

Recuperative Open Hearth Furnaces. Fitch Recuperator Co. (4-101)

Electric Melting Furnaces. Pittsburgh Lectromelt Furnace Corp. (4-61)

Electric Melting Furnaces, Top Charging. Swindell-Dressler Corp. (4-71)

Side-Blow Converter. Whiting Corporation. (4-75)

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Silvery Pig Iron. Jackson Iron & Steel Co. (4-64)

Non-ferrous Alloys. Metallurgical Products Co. (4-99)

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Control of Furnace Atmosphere. C. I. Hayes, Inc. (5-33)

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Quenching Oil Cooling Systems. Trane Co. The bulletin covers 4 basic cooling systems: Evaporative, shell-and-tube heat exchanger system, mechanical refrigeration and combination system. (5-309)

Fuel Oil Gasifier. American Gasifier Co., Inc. (5-138)

Oil Coolers. Bell & Gossett Co. (5-229)

High Temperature Heating Elements. Carborundum Co., Globar Div. (5-122)

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Heat Treatment Calculator for Alloy Steel. Peter A. Frasse & Co. (5-287)

Oil Valve. Hauck Manufacturing Company. (5-151)

Heat Exchanger for Metallurgical Operations. Niagara Blower Co. (5-293)

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Induction Hardening. Ohio Crankshaft Co. (5-246)

FURNACES

High-Speed Steel Furnace. Bennett Insured Steel Treating Co. This Interoval gas- or oil-fired furnace is for hardening of high-speed tool steels and dies, without decarburization or scaling. Heat is entirely by radiation in a non-oxidizing atmosphere. It can be used alternately as tool maker's forge; to heat long bars; and to treat small pieces in bulk. (5-310)

Heat Treating and Laboratory Furnaces. K. H. Huppert. Twelve types of furnaces and various temperature control instruments are described in a 20-page pamphlet. Heat ranges provided for are usually up to 2000 deg. F. (5-303)

Tempering and Drawing Furnace. Johnson Gas Appliance Co. It is designed for speedy tempering of tools, dies, small parts, non-ferrous castings and parts, and heating aluminum forgings and rivets. (5-307)

Forced Convection Tempering Furnaces. Morrison Engr. Corp. These convectors are available in box or pit type, electric- or gas-fired, with temperatures up to 1250 deg. F. Temperature uniformity within 5 deg. F. is claimed. (5-308)

Rotary Forge Furnace. Rhode Island Tool Co. Features of the furnace described in this bulletin are interchangeability of all forge rings, which may be replaced while hot, and quick uniform heating of stock. (5-311)

Furnaces and Furnace Equipment. Amsler-Morton Co., Inc. (5-256)

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Bright Hardening. Alfred Heller Heat Treating Co. (5-269)

The Nitriding Process. Nitralloy Corporation. (5-278)

Heat Treating High Speed Tool Steels. Tuff-Hard Corporation. (5-280)

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Masonry Saw. Clipper Mfg. Co. Four models, which "tailor-makes" odd sizes, and special shapes of refractories, glazed tile, brick, concrete and all masonry products are described. Claimed to save 50% in time, labor and greater salvage. (6-82)

Stopper Heads. Electro Refractories & Alloys Corp. A 4-page bulletin describes stopper heads for bottom-pour ladles in open hearths, steel foundries and electric furnace jobs. (6-84)

Hiloset, a Mortar. Mexico Refractories Co. For laying fire brick and for patching or repairing burned out spots in furnace linings. (6-83)

Liquid Coating for Refractory Brick, etc. Geo. R. Mowat Co. A coating material of the consistency of light-bodied paint, composed of several mineral substances of which the base has a melting point of 4000 deg. F., and applied by brush, spray or dipping, is described in this leaflet. (6-81)

Refractory Concrete.. Atlas Lumnite Cement Co. (6-66)

Insulating Fire Brick Data. Babcock & Wilcox Co. (6-43)

Refractory for Tapholes and Hot Repairs. Basic Refractories, Inc. (6-63)

Refractory Coating Material. Brickseal Refractory Co. (6-67)

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High Temperature Insulation. Illinois Clay Products Co. (6-51)

Medium-Duty Fire Brick. Ironton Fire Brick Co. (6-46)

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Electric Salt Bath Brazing. Ajax Electric Co., Inc. (7-63)

Solder for Aluminum and Its Alloys. Metalloy Products Co. (7-125)

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Electric Furnace Brazing. Westinghouse Electric and Manufacturing Co. (7-112)

ELECTRIC ARC WELDING

Arc Welding. Hobart Bros. Co. *Hobart Arc Welding News,* Vol. 1, No. 2, features a special swing frame grinder. Among the other items are: Saving $5000 in smokestack reconstruction, getting more production, etc. (7-130)

"Fleet-Fillet" Fast Arc Welding Technique. Lincoln Electric Co. Booklet on "Fleet-Fillet" welding technique contains 18 pages and 36 illustrations, including photos and line drawings. It is designed as ready reference material for plant production officials, welding operators and others. It is claimed this method permits 100% faster welding than conventional procedure. (7-132)

Tungsten Electrodes. Vascoloy-Ramet Corp. This bulletin gives information on full range of sizes of electrodes for atomic hydrogen welding. It points out how atomic hydrogen welds are exceptionally ductile, smooth, free from pinholes and same as surrounding metal. (7-133)

Electrode Consumption Calculator. Air Reduction Company. (7-90)

Electronic Welder for Precision Work. Allis-Chalmers Manufacturing Co. (7-115)

Electrode Color Chart. Arcos Corporation. (7-78)

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Austenitic Stainless Steel Electrodes. Harnischfeger Corporation. (7-110)

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Arc Welding Electrodes. Metal & Thermit Corporation. (7-47)

Corrosion- and Abrasion-Resistant Alloys. Wall-Colmonoy Corporation. (7-123)

GAS WELDING

Tool Steel Welding Rods. Welding Equipment & Supply Co. Sixteen pages devoted to complete descriptions of various types

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AMONG DEGREASING SOLVENTS

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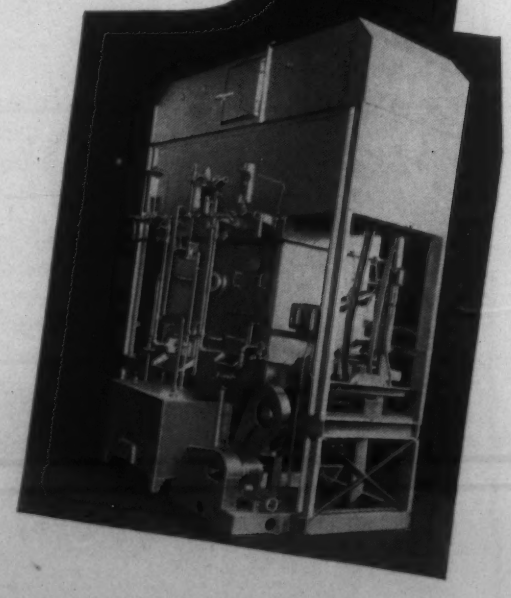

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of "Eurepa" rods, their uses in tool and die maintenance and for composite construction and necessary procedures. (7-131)

Bronze Welding Process. Automatic Gas-flux Manufacturing Co. (7-120)

Low Temperature Welding Rods. Eutectic Welding Alloys, Inc. (7-98)

Gas Welding Tips. National Cylinder Gas Co. (7-85)

Welding Torches, Nozzles, Tips, etc. Victor Equipment Co. (7-73)

RESISTANCE WELDING

Spot Welding Aluminum Alloys. Sciaky Company. The principles of the Sciaky system of stored energy spot welding and its practical application to the high-speed spot welding of aluminum aircraft alloys are presented in a 10-page technical article reprint. (7-134)

8. Metal-Working

FORMING

Etching Aluminum. Turco Products, Inc. Methods of etching aluminum preparatory to spot welding are described, headed by the cold-dip method employing Turco Koldweld, a one-tank operation. Two alternate methods are described. (7-135)

Drop-Hammer Stampings. Chambersburg Engr. Co. This 34-page pamphlet on Cecostampings describes and illustrates a radically different type of stamping machinery, designed chiefly for the aviation industry, but adaptable elsewhere. It deals with forming thin, hot work that cools quickly; embossing; work hard to set to final shape; producing small-quantity, short-run work at low cost, etc. (8-135)

Hydraulic Press. Hydraulic Press Mfg. Co. This 30-page pamphlet is a valuable contribution to the manufacture of artillery shell cases, useful particularly to the civilian manufacturer who enters war work. Theory and practice are well presented by word and picture. Use by aircraft makers is also treated. (8-140)

Assembling Presses. Denison Engineering Co. (8-120)

Straightening and Other Presses. A. B. Farquhar Co., Ltd. (8-75)

Lubrication of Metal Working Equipment. D. A. Stuart Oil Co., Ltd. (8-71)

FORGING

Forging Hammers. Lobdell Car Wheel Co., Nazel Hammer Div. (8-130)

MACHINING

Speed-and-Feed Calculator. Cincinnati Milling Machine Co. A handy pocket-size dial-type calculator for quickly selecting the right speeds and feeds for milling various materials is available from this company for 50 cents. (8-142)

Contour Sawing Machine. Continental Machines, Inc. A guide book for Doall operators tells how to stack parts in making stampings without dies, welding the saw band, how to grind and readjust new guide inserts, use of mirrors in filing operations, etc. (8-137)

Cutting Oil. Gulf Oil Corp. A few of the 34 pages are devoted to the right oil for each cutting operation. The major part is a condensed textbook: "Machining Guide for Modern Metals and Alloys," all very attractive and practical. (8-141)

Steel-Cutting Carbide Tools. McKenna Metals Co. This company has issued a 48-page "Kennametal Vest Pocket Manual," with chapters on selecting, designing, using, brazing and grinding. (8-136)

Wet-Dry Belt Grinding. Porter-Cable Machine Co. This is a 20-page well-arranged booklet, describing how the belt grinder can supplement the punch press, drill press, metal band saw, die and pressure casting machine, screw machine and lathe, etc. (8-138)

Diamond Tools. J. K. Smit & Sons, Inc. In this 22-page pamphlet topics are discussed such as: Truing and dressing of abrasive wheels; diamonds at work; mounting; correct angle; chatter marks; grinding coolant; avoiding taper; depth of dressing. (8-143)

Cutting Oils. Cities Service Oil Co. (8-19)

Oil Filters. Cuno Engineering Corp. (8-108)

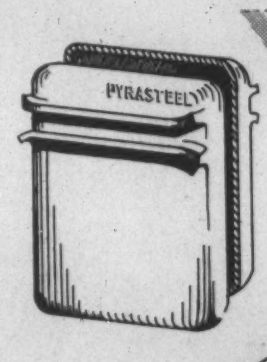
Grinders for Tools. Hammond Machinery Builders, Inc. (8-90)

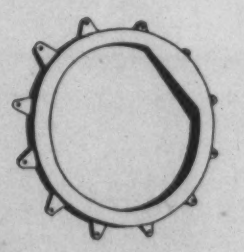
Please Use the Coupon on Page 933

SUSTAINED HIGH PRODUCTION

of Heat-Treated Munitions Parts is assured by the use of

PYRASTEEL



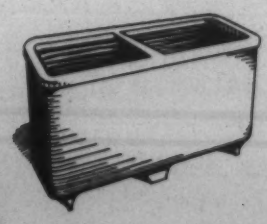


There can be no let-down in output when victory is at stake.

PYRASTEEL is the safe and sure heat-resisting alloy to use for heat treating vital parts of equipment.

It keeps production lines moving, and prevents "bottle-neck" delays in the heat-treating department.

PYRASTEEL annealing pots, furnace parts, grids, rollers and guides, give the dependable service, so necessary in maintaining today's emergency schedules.



PYRASTEEL
for high temperatures

CHICAGO STEEL FOUNDRY CO.
3701 S. Kedzie Ave., Chicago, Ill.
Makers of Alloy Steel for 30 Years

Cylindrical Grinding Machines. Norton Co. (8-134)

Cutting and Grinding Facts. Sun Oil Co. (8-85)

Filters for Lubricants. U. S. Hoffman Machinery Corp., Filtration Div. (8-125)

METAL POWDER PROCESSING

Conical Mills. Hardinge Co., Inc. This 28-page booklet is a very complete exposition of grinding coarse into fine particles by this equipment, and is well illustrated. Principles, theories and practice receive appropriate space. (8-144)

Presses for Powder Metallurgy. E. W. Bliss Company. (8-113)

Presses for Powdered Metals. Kux Machine Co. (8-62)

Batch Mixers. Lancaster Iron Works, Inc. (8-129)

Powder Mixing Machines. National Engineering Co. (8-92)

Metal-Powder Mixers. Patterson Foundry & Machine Co. (8-114)

Mixers for Metal Powder. Reed Machinery Co. (8-115)

Compressing Machines for Metal Powders. F. J. Stokes Machine Co. (8-119)

9. Cleaning • Finishing

CLEANING

Foundry Cleaning. American Foundry Equipment Co. This is a 12-page reference catalog, with many pictures, describing airless blast cleaning equipment, Tablasts, special cabinets, dust collectors, etc. (9-157)

Degreasing Solvent. Curran Corp. Gunk concentrate, self-emulsifying solvent, is said to be especially effective in degreasing mechanisms of complicated and delicate designs without disassembly. (9-160)

Cleaning Machines. Alvey-Ferguson Company. (9-119)

Electrochemical Descaling. Bullard-Dunn Div., Bullard Company. (9-88)

Pre-Cleaning for Plating. Macdermid, Inc. (9-110)

Airless Blast Cleaning. Pangborn Corporation. (9-73)

Buffing, Polishing and Rubbing Compositions. Park Chemical Co. (9-123)

Concentrated Industrial Cleaners. Pennsylvania Salt Manufacturing Co. (9-46)

CHEMICAL TREATMENTS

Corrosion Protection. Alox Corporation. (9-92)

Blackening Iron and Steel. Alrose Chemical Co. (9-95)

Blackening Steel Products. Heatbath Corp. (9-83)

Chemicals for Protecting and Coloring Metal Surfaces. Mitchell-Bradford Chemical Co. (9-152)

ELECTROPLATING

Plating Rectifier. W. Green Electric Co., Inc. This 18-page pamphlet describes a new aid to better plating, which converts high-voltage alternating current to low-voltage direct current, the "heart" being a selenium rectifier. (9-158)

Hard Chromium Plating. United Chromium, Inc. A 16-page data bulletin summarizes applications where industrial plating saves materials and man-hours. It suggests how existing plating equipment can be converted to "hard" chromium plating. (9-159)

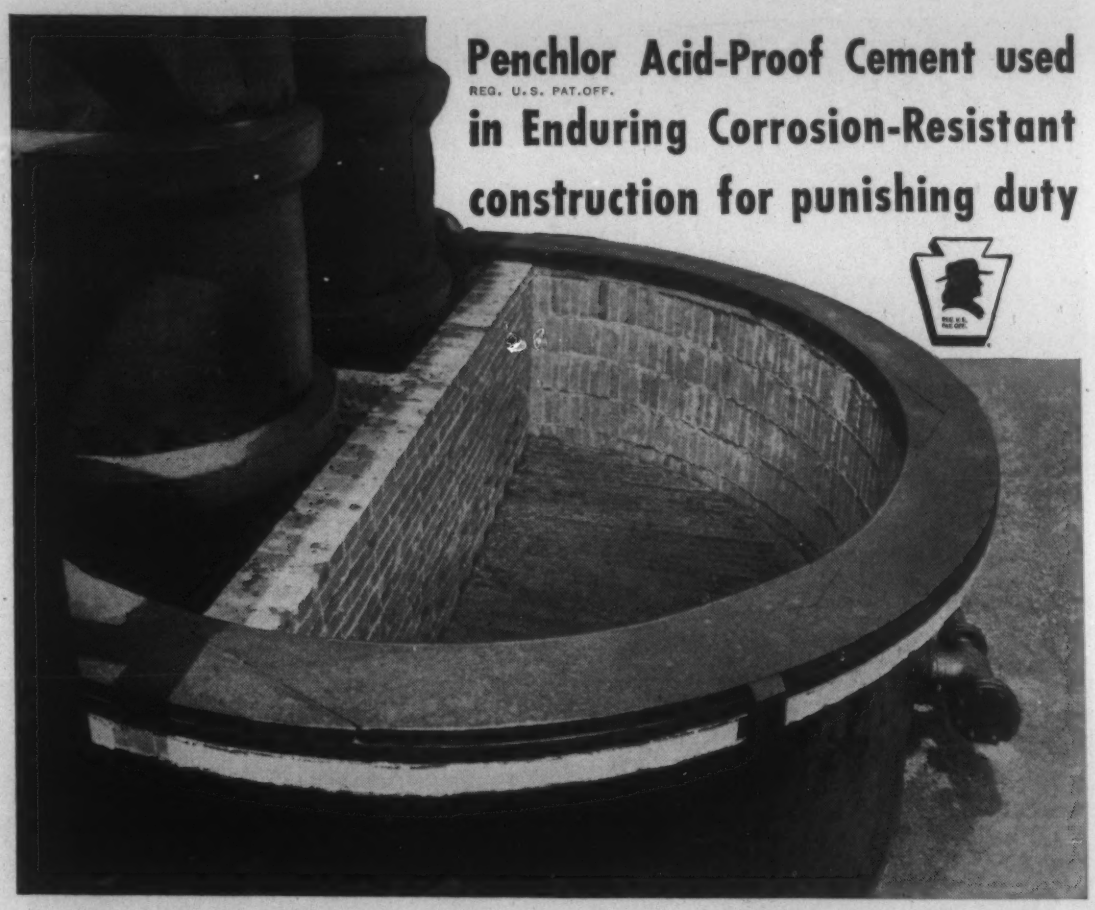
Plating Solution Filtration. Alsop Engineering Corp. (9-101)

Electroplating Generators. Columbia Electric Manufacturing Co. (9-79)

Electrodeposited Coatings. Hanson-Van Winkle-Munning Company. (9-143)

METALLIC COATINGS (NON-ELECTROLYTIC)

Metallizing Process. Metallizing Eng. Co., Inc. A 16-page bulletin tells how to eliminate replacements by building up worn diameters with any desired wear and corrosion-resistant sprayed metal; how the metal-spray process salvages rapidly mismachined parts and defective castings. (9-164)



Penchlor Acid-Proof Cement used in Enduring Corrosion-Resistant construction for punishing duty

REG. U.S. PAT. OFF.

This acid-proof, brick-lined tank, in a leading chemical plant, must stand up to the toughest kind of service. Scrap iron, in half ton loads, is dumped into such tanks twice a day, to be treated by hot acid in the manufacture of ferrous and ferric chloride. Some of these tanks have been in service over six years.

The quick-setting and self-hardening properties of Penchlor Acid-Proof Cement recommend it highly for new construction—particularly now, when time-saving is so important in war efforts. With Penchlor Acid-Proof Cement you can get brick-lined equipment into service without delay.

If you require a cement of exceptional strength and high resistance to abrasion, you will be interested in these Pennsalt *resin* cements: *Asplit*, for conditions always acid . . . *Causplit*, for alternate acid and alkaline conditions. These are easy to handle and will withstand a wide range of corrosive conditions, up to 350 degrees F.

Our engineers have had wide experience handling acids and alkalis in our own plants and are at your service at anytime, without obligation. Write fully. Or, if you prefer, use the coupon.

PENNSYLVANIA SALT MANUFACTURING COMPANY
Chemicals
1000 Widener Building, Philadelphia
New York • Chicago • St. Louis • Pittsburgh • Wyandotte • Tacoma

PENNSYLVANIA SALT MANUFACTURING COMPANY
Dept. MA, 1000 Widener Bldg., Philadelphia, Pa.
I want information on corrosion-resistant cements for use in linings to handle

Please send me a free copy of your booklet
Booklet No. 3 on "Penchlor Acid-Proof Cement"
Booklet No. 5 on "Asplit and Causplit Cements"

NAME_____
COMPANY_____
ADDRESS_____

ORGANIC FINISHING

Corrosion-Resistant Coating. Corrosion Control Corp. A 4-page bulletin gives interesting information about Co-Res-Co—a corrosion-resistant coating that can be applied to metals, wood, concrete, etc. by spraying, brushing or dipping to provide resistance against various strong corrosives. (9-163)

Spray Booth Cleaning Compound. Detroit Rex Products Co. Keeps vital parts of a wet spray booth from becoming fouled by paint pigments, says this bulletin. Lines, nozzles and eliminators are kept free and open. (9-156)

Industrial Finishes. Maas & Waldstein Co. The booklet provides makers of armament products essential information on M & W finishes conforming to U. S. Government specifications. (9-154)

Cleaning Metal Munitions. Magnus Chemical Co., Inc. (9-109)

PICKLING

Pickling of Steel. Enthone Co. "Modern Pickling of Iron and Steel," 14 pages, states that correct pickling is important for many more reasons than ordinarily realized. The maker offers a new aid to pickling—Enthone acid addition agent. Use on springs and in electrolytic pickling is treated. (9-162)

Corrosion Resistant Ceramics. Atlas Mineral Products Co. (9-72)

Pickling Inhibitors. Oakite Products, Inc. (9-112)

POLISHING

Polishing and Buffing Booklet. Lea Manufacturing Co. (9-147)

10. Testing • Control

CONTROL INSTRUMENTS

Thermocouples and Accessories. Arklay S. Richards Co., Inc. Single page devoted to brief descriptions. (10-265)

Radiation Pyrometers. Bristol Co. Folder describes new line of Pyrovac pyrometers. Theory and use are described, with engineering drawings employed. (10-266)

Potentiometer Pyrometer and Accessory Equipment. Brown Instrument Co. This revised catalog of 40 pages features temperature measurement by the radiation method with a description of the Brown Radiomatic sighting tube. Automatic control systems are explained. (10-259)

Temperature Regulators. Sarco Co., Inc. Sixteen pages are devoted to photos, diagrams and tables of regulators for hot water heaters, process tanks, fuel oil storage, dryers, kilns, ovens, air conditioning refrigeration, handling temperatures up to 400 deg. F. (10-263)

Thermocouples and Accessories. Charles Engelhard, Inc. (10-154)

Pickling Temperature Control. Foxboro Co. (10-178)

Pyrometer Control. Illinois Testing Laboratories, Inc. (10-42)

Flue-Gas Analysis Equipment. Leeds & Northrup Co. (10-222)

Immersion Pyrometer. Pyrometer Instrument Co. (10-8)

Control Gages. Weston Electric Instrument Corp. (10-239)

Temperature and Measuring Control. Wheelco Instruments Co. (10-190)

HARDNESS TESTING

Hardness Tester for Soft Metals. Barber-Colman Co. (10-218)

Equipment for Hardness Testing. Clark Instrument, Inc. (10-229)

Microhardness Tester. Eberbach & Son Co., Inc. (10-156)

Portable Brinell Hardness Tester. Andrew King. (10-148)

Surface Finish Tester. Taber Instrument Co. (10-153)

INSPECTION DEVICES

Tool-Room Clinometer. R. Y. Ferner & Co. The Cooke optical clinometer, intended for general use in tool room, particularly for measuring angles, is described. Tables are provided, giving degrees, minutes and decimals of minutes to two places for the sub-division of the circle to any number of equal parts from 2 to 200. (10-258)

Please Use the Coupon on Page 933

BROKEN bottles to the layman—cullet to the glass manufacturers. This scrap glass is segregated according to color, washed, uniformly broken and shipped to the glass factories, where it is introduced into the glass batches to produce a better, cheaper product.

Essential to the successful use of cullet is the removal of all iron which would discolor or spoil the new glass, a job ably performed by Dings Magnetic Separators.

This is just one of thousands of applications of magnetic separation to lower costs, speed work and produce better results.

For the metal working field it's Dings for scrap separation, removing iron from foundry sand and handling metal.

Write today for the Magnetic Alchemy Bulletin describing the latest equipment for these jobs.

Separation headquarters since 1899.

Dings MAGNETIC SEPARATION

DINGS MAGNETIC SEPARATOR CO., 533 E. Smith St., Milwaukee

Surface-Roughness Tester. Physicists Research Co. Bulletin describes how the Profilometer measures surface roughness, or the average vertical dimensions of surface irregularities, such as measurement of crankshaft bearing surfaces. (10-262)

Measuring Coating Thickness. American Instrument Co. (10-118)

Precision Gages. Federal Products Corp. (10-94)

Electronic Micrometer. Instrument Specialties Co., Inc. (10-228)

Magnaflux Inspection. Magnaflux Corp. (10-248)

New Illuminated Magnifier. E. W. Pike & Company. (10-58)

MECHANICAL TESTING

Dynamic Balancing Machines. Bear Mfg. Co., Industrial Div. The need for balancing machines as an aid to design and manufacture of quiet, long-lived machines, and the various types offered by this company, are presented in a 16-page booklet. (10-264)

Torsion Impact Machine. Baldwin-Southwark Division. (10-99)

Testing Machines for Plastics. Tinius Olsen Testing Machine Co. (10-252)

Tensile Testing of Fine Wire. Henry L. Scott Co. (10-55)

METALLOGRAPHIC EQUIPMENT

Metallurgical Laboratory Equipment. Adolph I. Buehler. (10-199)

Presses for Mounting Metallographic Specimens. Fred S. Carver. (10-255)

Metallurgical Polishing Equipment. Tracy C. Jarrett. (10-174)

RADIOGRAPHY

Industrial Radiography with Radium. Canadian Radium & Uranium Corp. This 80-page book presents this important subject—the non-destructive inspection of metals radiographically—most usefully. One of the most thorough expositions of gamma-ray radiography available. (10-261)

Modern Industrial Radiography. Eastman Kodak Company. (10-177)

The X-ray in Industry. General Electric X-ray Corp. (10-10)

Industrial X-ray. Kelley-Koett Manufacturing Co. (10-185)

X-ray Film and Supplies. Picker X-ray Corp. (10-217)

Radium for Radiography. Radium Chemical Co. (10-81)

X-ray Machines. Westinghouse X-ray Div. (10-164)

LABORATORY AIDS

Salt Spray Test Containers. Alberene Stone Corp. of Virginia. (10-120)

Laboratory Apparatus Catalog. Burrell Technical Supply Co. (10-230)

Please Use the Coupon on Page 933

Rapid Moisture Determinations of Sands. Colloid Equipment Co., Inc. (10-242)

Metallurgical Laboratory Equipment. Harry W. Dietert Co. (10-50)

High-Speed Electrolytic Analysis. E. H. Sargent & Co. (10-219)

11. General

Dust Control. American Air Filter Co., Inc. (11-23)

Magnetic Separators and Lifting Magnets. Dings Magnetic Separator Co. (11-38)

Air Compressors and Vacuum Pumps. Fuller Company. (11-21)

Metal Turnings Crusher. Jeffrey Manufacturing Co. (11-52)

Chilling Unit for Sub-Zero Temperatures. Kold Hold Manufacturing Co. (11-34)

Magnetic Separators. Magnetic Engineering & Manufacturing Co. (11-51)

Water Softening. Permutit Company. (11-42)

Drum Magnetic Separators. Stearns Magnetic Manufacturing Co. (11-27)

Three-Stage Compressors. Worthington Pump & Machinery Corp. (11-19)

WASTE IS Sabotage

Conserve to Serve

★ NATIONAL DEFENSE ★

Our recently perfected recovery process eliminates waste of INDIUM in plating baths by conserving the excess INDIUM residue.

INDIUM provides nonferrous metals and alloys with greater tensile strength and fatigue resistance, and protects surfaces against wear, corrosion, abrasion, and friction. INDIUM is capable of high polish, retards tarnish, and improves ductility and extrudability.

INDIUM is a domestic mined, commercial metal with many uses for industry. Ample supply and prompt deliveries prevent production delays.

Today delays are dangerous. Write now and find out how INDIUM CAN SOLVE YOUR SPECIFIC PROBLEM.

FULL EXPLANATION of our recovery process *which prevents waste* will be mailed to you upon request, without cost or obligation.

THE INDIUM CORPORATION OF AMERICA

Research and Development Office
60 East 42nd Street, N. Y. C.

Sales Office and Laboratory
805 Watson Place, Utica, N. Y.

Greater precision in slag control

Bethlehem metallurgical observer compares slag pancake with standard slag samples.

In the task of increasing the output of quality alloy steels needed for the war-production program, every advance in steel-making, no matter how small of itself, assumes a new and vital importance. In Bethlehem's modern mills, every available method for stepping up production is being applied, and new refinements are constantly being developed. Control of slag composition in the open-hearth process is a case in point.

General method already known

For a number of years a simple and rapid method of determining slag composition has been generally available. Known as the slag-pancake method, the test is based on visual examination of a disk or pancake of slag, poured and allowed to solidify in a special shallow mold. To an experienced observer, the surface characteristics of the pancake—its color, texture and conformation—tell the story of lime-silica ratio and iron content, these being the essential facts needed in making up the proper slag for a given heat of steel.

New development more accurate

But today, as applied at Bethlehem's open-hearth furnaces, the slag-pancake method has been developed a step further. In the effort to make it a more consistently accurate test and to enable even the relatively inexperienced observer to use it effectively, Bethlehem's research engineers have developed a "sample table" of standard slag-pancakes of known composition, arranged in rows and columns in accordance with their varying analyses. Now, in testing slag throughout a heat, the melter or observer compares each new sample with the samples on the table. A few seconds suffice to identify the new sample with complete accuracy. With this added development, the slag-pancake method is now being applied to open-hearth operations as a routine procedure, without the need for long and arduous training of special observers to interpret the results.

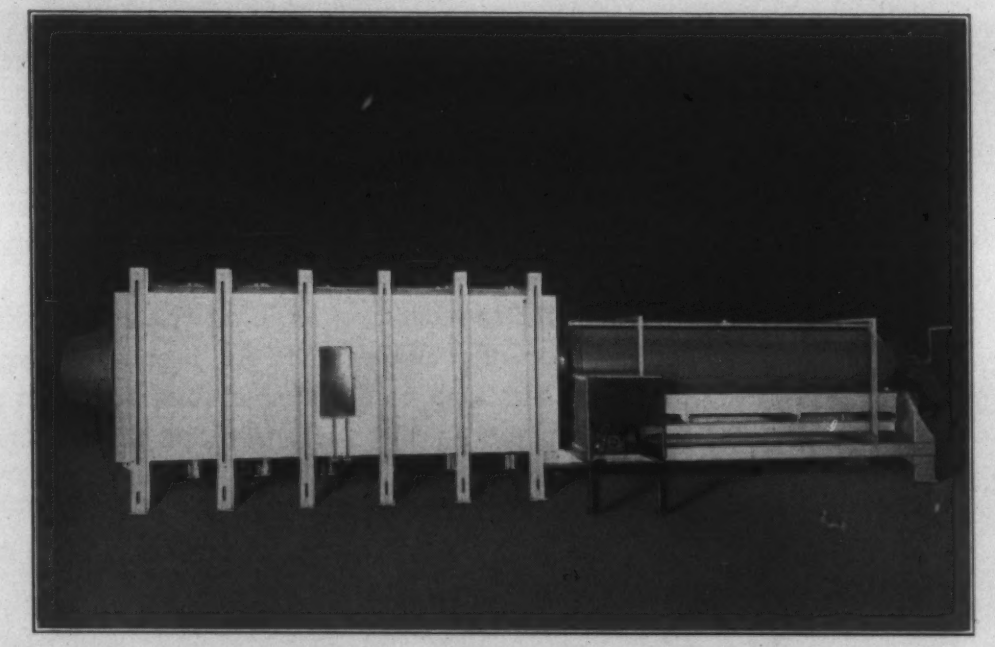
Result is greater efficiency

Thus, as a result of a seemingly small advance in practice, it is now possible to reduce both volume and basicity of slag to the just-essential level, with more efficient operation of furnaces, shorter working time per heat and better conservation of alloying elements.

BETHLEHEM STEEL COMPANY

BETHLEHEM STEEL

BRASS
gives way to
STEEL
for Cartridge Cases



The Model CRR Furnace is made in sizes to take care of production from 1000 pounds per hour up.

Over Two Million Dollars worth of this equipment has been ordered during the past year for annealing Steel and Brass cartridge cases and bullet jackets.

Buy "AMERICAN"

Write for bulletin #80

American Electric Furnace Company

29 VON HILLERN ST. ★ BOSTON, MASS., U. S. A.

Industrial Furnaces for All Purposes

IMAGINEERING: GETTING OUT OF THE GROOVE

THESE FOUR YOUNG WOMEN, so earnestly mastering the art of torch-welding aluminum, suggest that someone, somewhere, has checked out of the groove and started some practical Imagineering.

THEY PROVE what we've been saying for years: Alcoa Aluminum is easy to fabricate. The man who started the school where these girls are learning, and graduating to war jobs, simply had imagination enough to believe that

easy really means *easy*. Then he did something about it!

IMAGINEERING is letting your imagination soar and then engineering it down to earth. It is ingenuity in modern dress.

IT IS THE THING that has enabled the aluminum industry to keep on top of a plane schedule, increased tremendously in numbers, but also calling for almost twice as much aluminum per plane as the average plane needed two years ago.

IT IS WHAT EVERY ONE OF YOU are doing on your war job. Simplification, standardization, training. New methods, new materials, new records.

THIS WAR is showing Americans what they really can do if they try.

LET'S MAKE a vow to carry this same spirit over into postwar America. We'll all have the skills, the habit of work, the thrill of doing. There will be lots of aluminum to make into better products than peacetime America ever knew. It will be a great day for Imagineers.

Aluminum Company of America, 2162 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA ALUMINUM

How Medium-Carbon Ferromanganese Helps to Speed the Production of Steel

WHEN medium-carbon ferromanganese is used in the production of steel, a decreased amount of carbon is added to the bath. Hence it is not necessary to oxidize the bath so severely to reduce the carbon content to the desired level. As a result, metal losses are decreased. The amount of deoxidation required is less. Recoveries of alloying elements are higher. Refractory maintenance is reduced. The heat can be made in one-quarter to one-half hour less time ... All these factors, in addition to reducing costs, hasten and increase the production of steel.

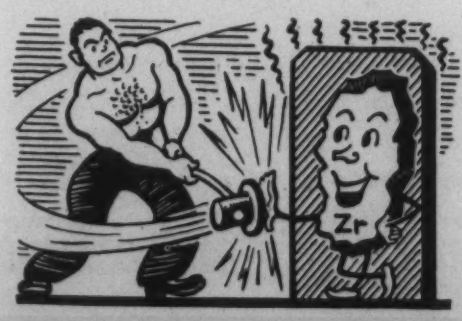
One of our metallurgists will gladly tell you more about medium-carbon ferromanganese and can give you practical help in its use. He can tell you also about the many other "Electromet" ferro-alloys and how they can be used to produce quality steel at high speed and low cost. This service represents more than 35 years' experience in the production and use of high-grade ferro-alloys, and is yours for the asking whenever you need it.

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York, N. Y.

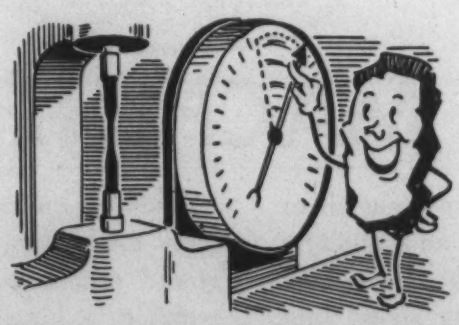
Items of Interest about other "Electromet" Ferro-Alloys

•

Zirconium Raises Shock Resistance of Manganese Steel — Medium-manganese, steel containing 1.50 per cent manganese, when treated with zirconium, shows higher shock resistance and increased ductility without loss of tensile strength. The increase in resistance to shock in the heat-treated, rolled steels is, in some cases, as much as 50 per cent.



Vanadium Increases Strength and Toughness of Medium-Manganese Steel Castings — The averaged values of a series of tests showed that the addition of 0.10 per cent vanadium to a medium-manganese steel raised the yield point from 52,000 to 70,200 lb. per sq. in., and increased the Izod impact from 20 to 58.7 ft.-lb. Tensile strength, elongation, and reduction of area were also slightly increased.



Calcium - Manganese - Silicon Prevents Pinholes in Steel Castings—In repeated tests, calcium-manganese-silicon used as a ladle deoxidizer has proved beneficial for counteracting gases which penetrate the steel when it is being cast. The elimination of these gases reduces the formation of pinholes in the castings.

Silico-Manganese Is a Quick, Thorough Deoxidizer for Steel — Silico-manganese combines the effects of two powerful deoxidizers. This combination dissolves rapidly in the molten metal and forms a light, fluid, low-melting manganese silicate slag which quickly rises to the surface and leaves the steel clean and ready for tapping in 10 to 15 minutes, thus speeding the melting process.

Write for This Booklet — If you want more information about these and the many other "Electromet"

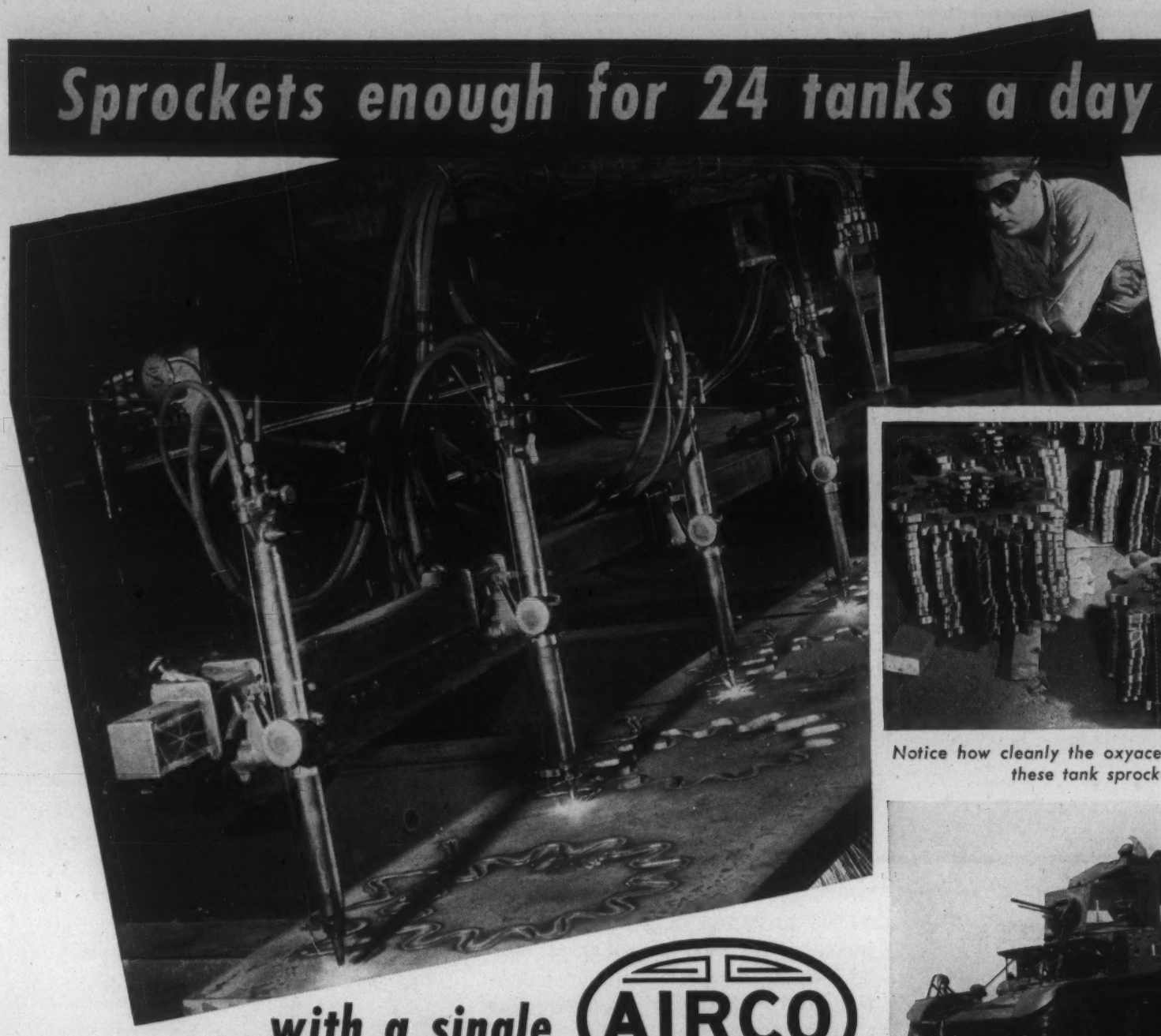
ferro-alloys and metals, their use, and the service that goes with their purchase, write for this 24-page booklet entitled "Electromet Products and Service."

Electromet
Trade-Mark
Ferro-Alloys & Metals

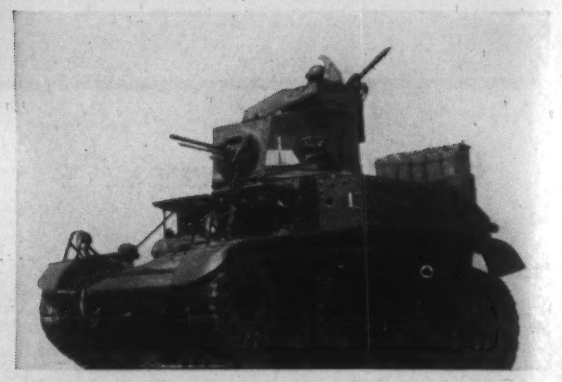
Distributed through offices of Electro Metallurgical Sales Corporation in Birmingham, Chicago, Cleveland, Detroit, New York, Pittsburgh, and San Francisco. In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario.

The word "Electromet" is a registered trade-mark of Electro Metallurgical Company.

Sprockets enough for 24 tanks a day . . .



Notice how cleanly the oxyacetylene flame cuts these tank sprockets.



Thousands of tanks like these will soon be taking their place in our armored forces — thanks, in part, to the time-saving production that oxy-acetylene cutting makes possible.

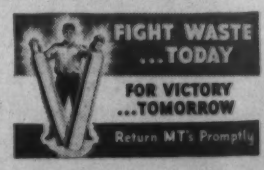
. . . with a single AIRCO

GAS CUTTING MACHINE

At this plant production of vital tank parts like these drive sprockets is keeping well ahead of the huge tank-building program, thanks to this Airco Travograph. In only twenty minutes, this machine accurately cuts both the inside and outside peripheries of four identical drive sprockets. Simply by changing the template which guides the torches, this machine can be made to cut many other shapes. While for cutting only one or few parts, not even a template is necessary, when the Travograph is equipped with a manual tracing device.

This typical example of stepped-up production is only one of many ways in which the oxyacetylene flame is helping to produce our country's arms more quickly and economically than ever before. The oxyacetylene flame prepares with speed and accuracy plate edges for both arc and gas welding. It hardens steel to any desired depth . . . cleans metal surfaces to assure long lasting paint jobs, resistant to rust and corrosion.

Air Reduction's war-time policy is to help American industry do the tough job we all face. Our nation-wide field engineering service and our research facilities on any problem involving the oxyacetylene flame and the electric arc are at your disposal.



Air Reduction

General Offices: 60 EAST 42nd ST., NEW YORK, N. Y.

IN TEXAS
MAGNOLIA-AIRCO GAS PRODUCTS CO.
General Offices: HOUSTON, TEXAS
OFFICES IN ALL PRINCIPAL CITIES

AIRCO WILSON

IDLE CYLINDERS ARE PRODUCTION SLACKERS: *Keep 'em rolling for victory!*

. . . AND we are proud that Aristoloy and Coppco steels — in tanks, guns, ships, munitions and all the other implements of war — are helping our armies march to Victory.

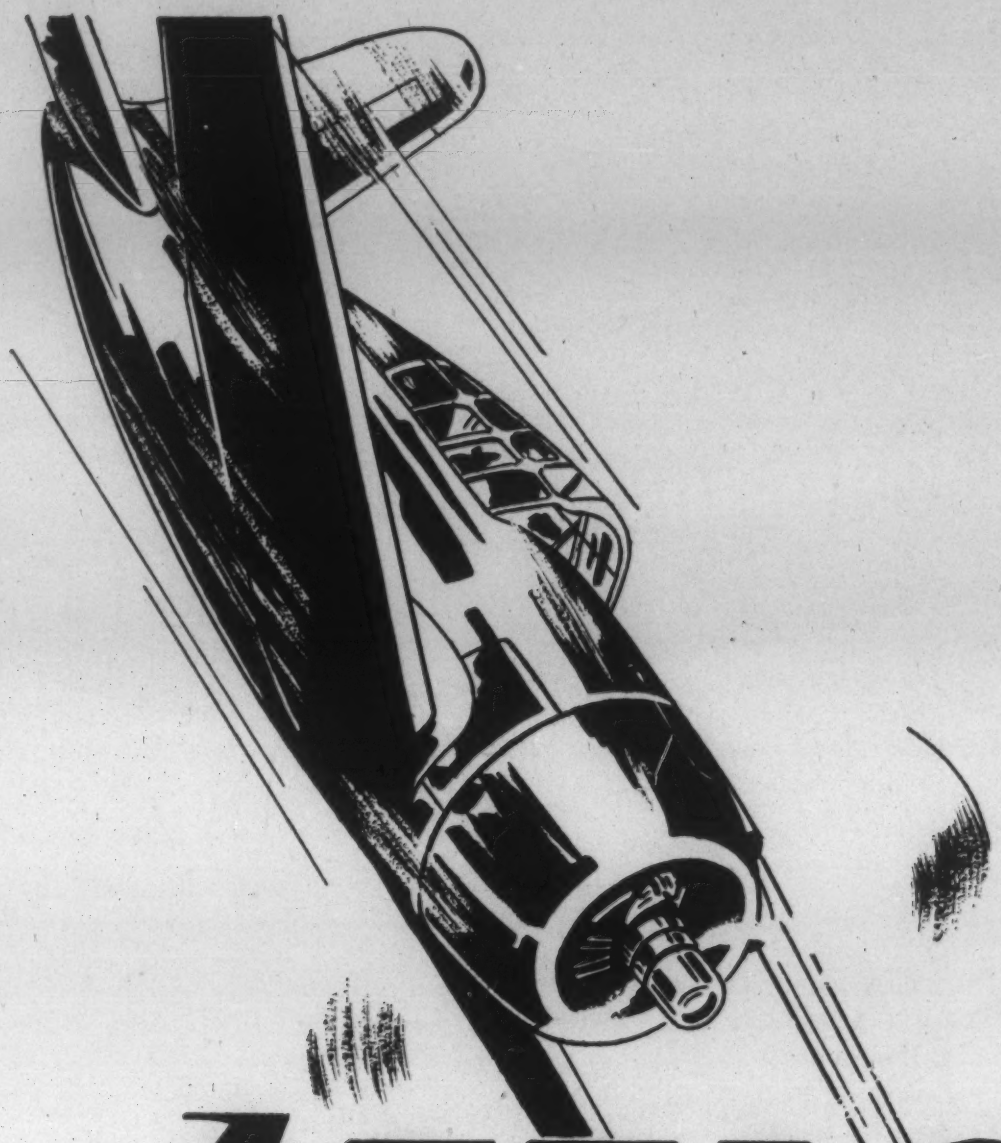
"THE WILL TO MAKE GOOD STEEL"

CARBON TOOL STEELS · ALLOY TOOL STEELS
AIRCRAFT QUALITY STEELS · STAINLESS STEELS
NITRALLOY STEELS · BEARING QUALITY STEELS

ARISTOLOY STEELS

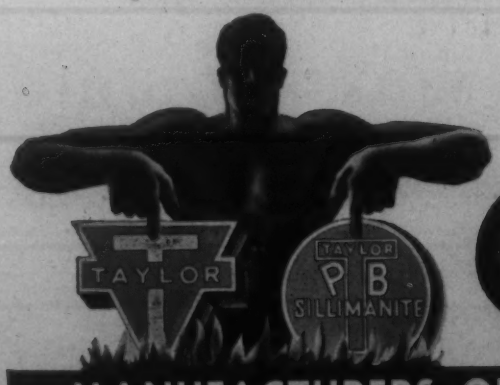
COPPERWELD STEEL COMPANY WARREN, OHIO

COPPCO TOOL STEELS



ATTACK!

We are "ATTACKING" now—on our way to Victory. Speed that Day of Victory—eliminate production delays. In Industry geared to War—time tested and proven TAYLOR-MADE refractories help eliminate costly delays. We are "ALL-OUT" in our effort to supply your REFRACTORY requirements.

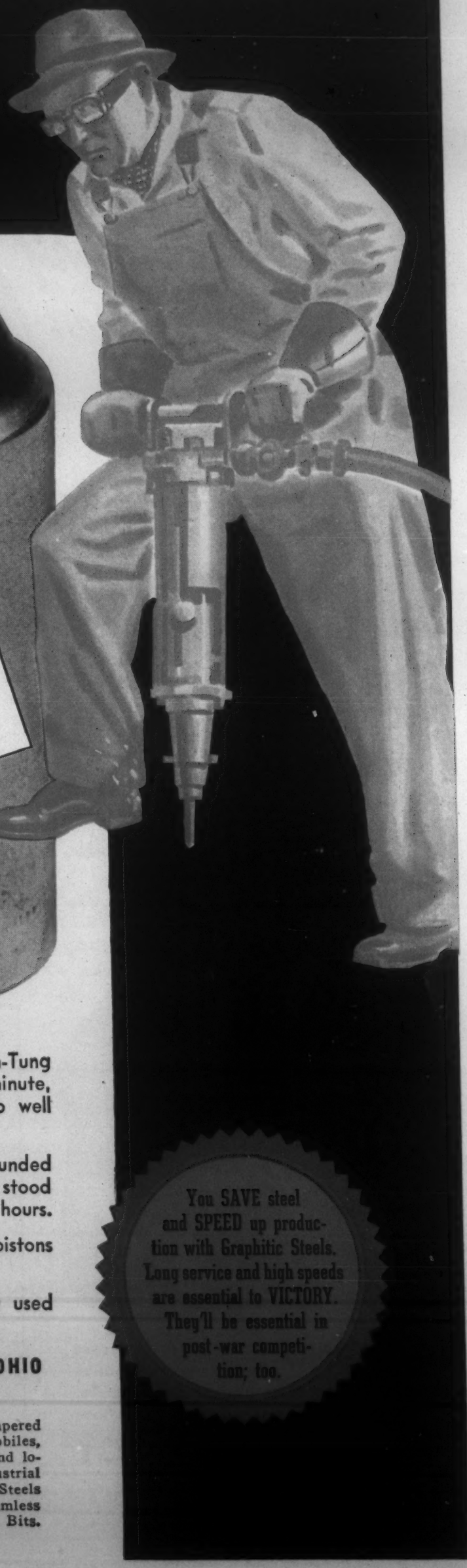


CHAS. TAYLOR SONS Co.

MANUFACTURERS OF REFRACTORIES • CINCINNATI • OHIO • U. S. A.

AIR HAMMER *Pistons*

Air hammer piston on left is made of Graph-Tung Steel. After 5,280 hours, it showed little sign of wear. The hammer on the right, made of ordinary tool steel, failed after 546 hours.



Several years ago we made 25 air hammer pistons of Graph-Tung Steel. When one of these, operating at 2,500 strokes per minute, achieved a record of 5,280 hours of service we were so well pleased that we ran an advertisement telling all about it.

We thought then and we still think our enthusiasm was well founded because companion pistons made of standard tool steels stood up under the same service conditions a maximum of 546 hours.

Here's the sequel to this story. These 25 Graph-Tung Steel pistons averaged 7,680 hours of service life.

The less expensive Graph-Mo Steel is now being widely used with similar results.

You SAVE steel and SPEED up production with Graphitic Steels. Long service and high speeds are essential to VICTORY. They'll be essential in post-war competition; too.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO
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TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
GRAPHITIC STEELS

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

Save steel Make machinery last longer!

➡ To save steel and make machine parts more durable without increase of weight use

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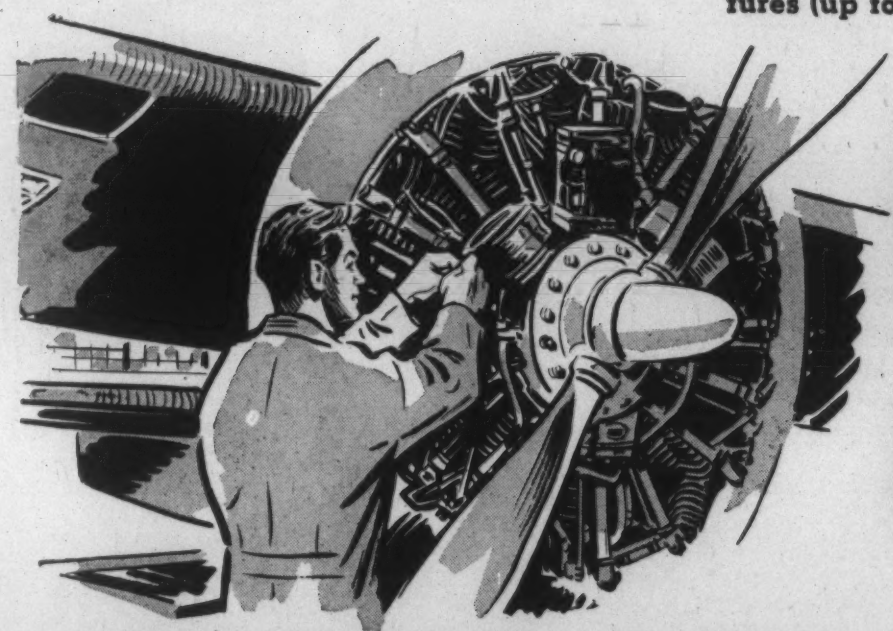
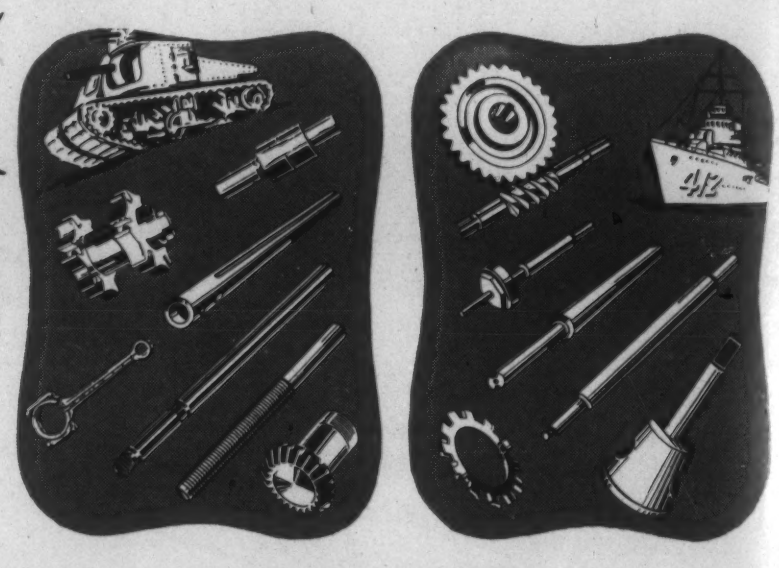
Nitrided Nitralloy produces the hardest steel surface known (up to 1200 Vickers), allows control of core properties, retains its physical characteristics even at sustained high temperatures (up to 1100° F).





Nitralloy is daily demonstrating its life-extending resistance to wear and fatigue in high-speed aircraft engine cylinders; in bushings, gudgeons, spacers and plates of tanks; in motor trucks, marine equipment and industrial machinery of many types.

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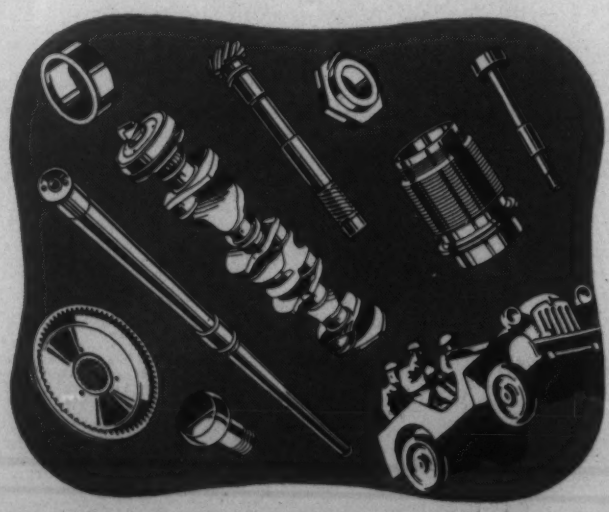

NITRIDING is the process of case hardening certain alloy steels by means of a nitrogenous medium, such as ammonia gas. The alloy steels that are most suitable for Nitriding are known as NITRALLOY

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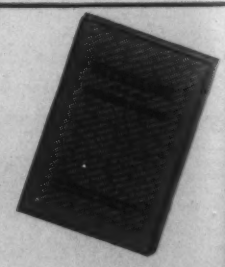

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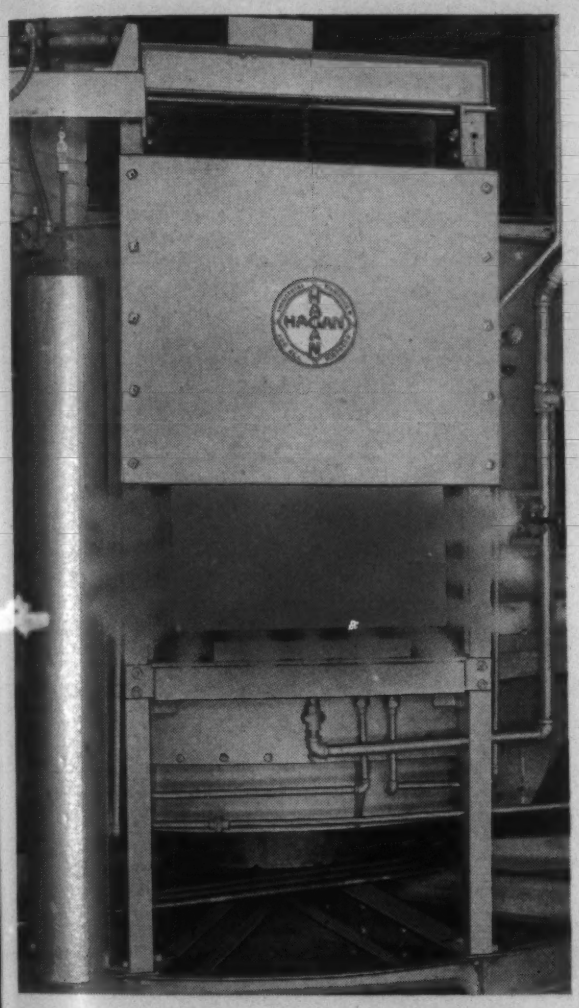

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CASTINGS FOR HEAT CORROSION
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Consult Misco, now, on your annealing and carburizing box requirements. Your inquiries by telephone or wire will receive prompt attention.

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HIGH TEMPERATURE ALLOY SHEET WALL CARBURIZING BOXES

for Conservation of Nickel and Chromium

Because Misco sheet wall carburizing and annealing boxes are thinner than most cast boxes, less nickel and chromium are required to produce them. But the service life of Misco sheet boxes often exceeds that of the heavier cast box by a substantial margin. And, of course, Misco sheet boxes are easier to handle and require less time to reach carburizing temperatures.

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Heat and Corrosion Resistant Alloys

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MOLYBDENUM-TUNGSTEN HIGH SPEED STEEL

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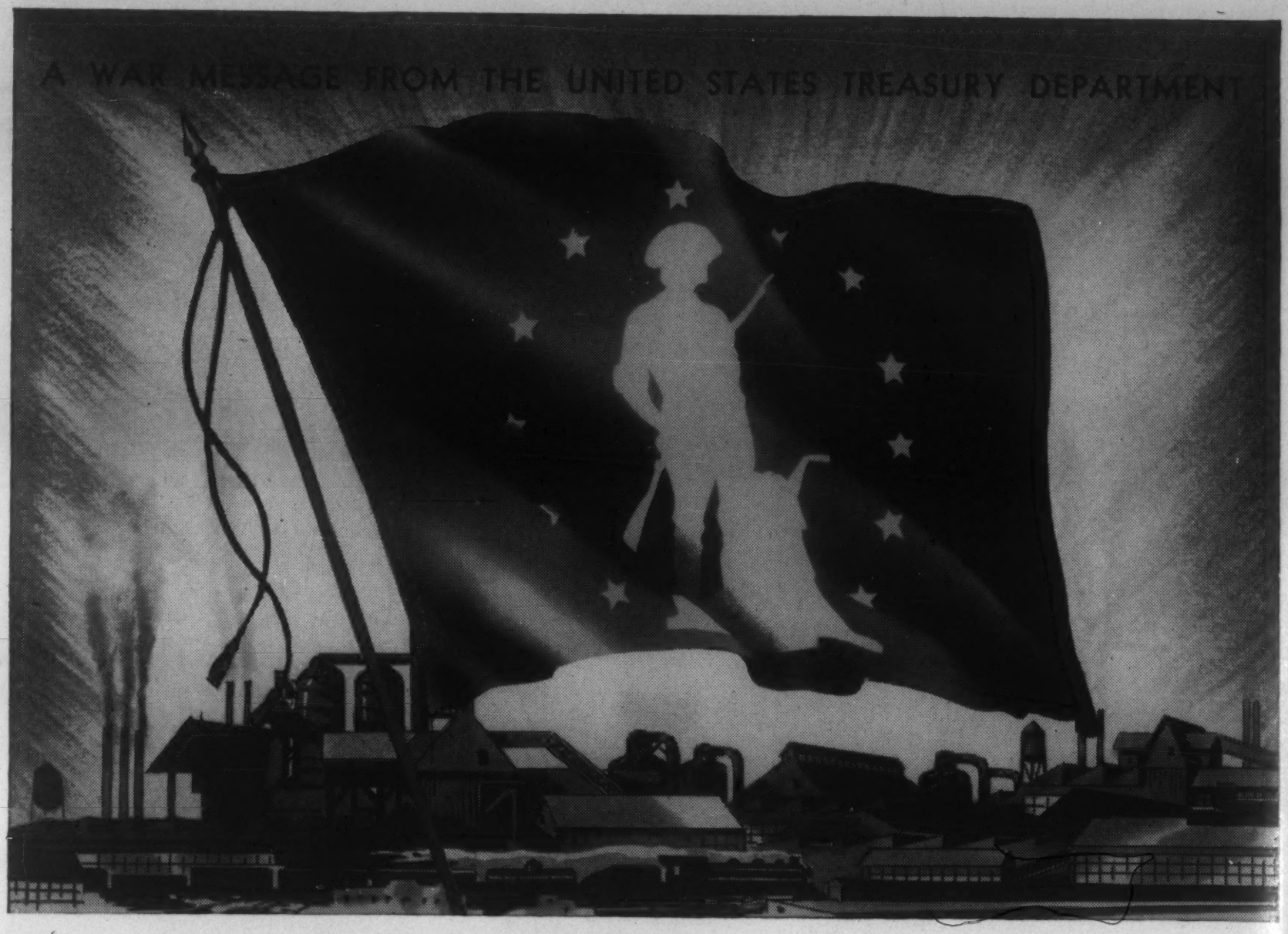

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IT doesn't go into the smoke of battle, but wherever you see this flag you know that it spells Victory for our boys on the fighting fronts. To everyone, it means that the firm which flies it has attained 90 percent or more employee participation in the Pay-Roll Savings Plan . . . that their employees are turning a part of their earnings into tanks and planes and guns *regularly,* every pay day, through the systematic purchase of U. S. War Bonds.

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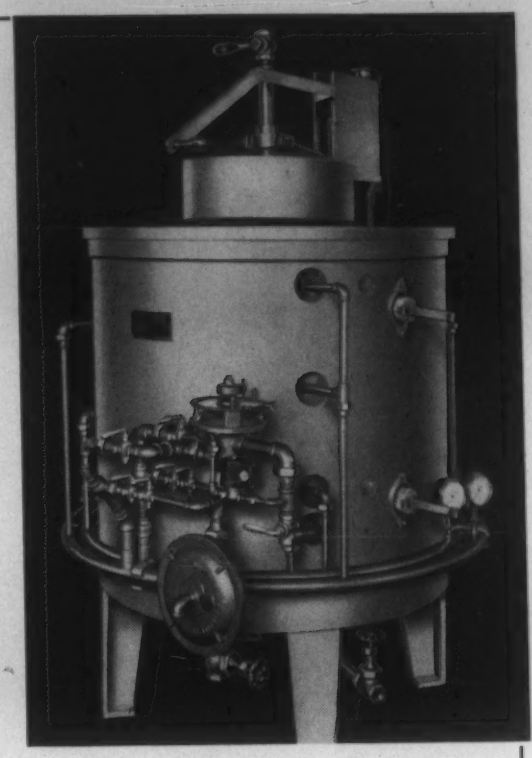

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A Superior Copper

FOR ALL PURPOSES

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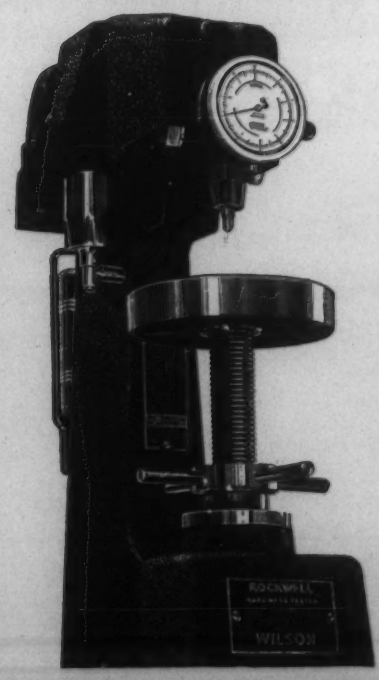

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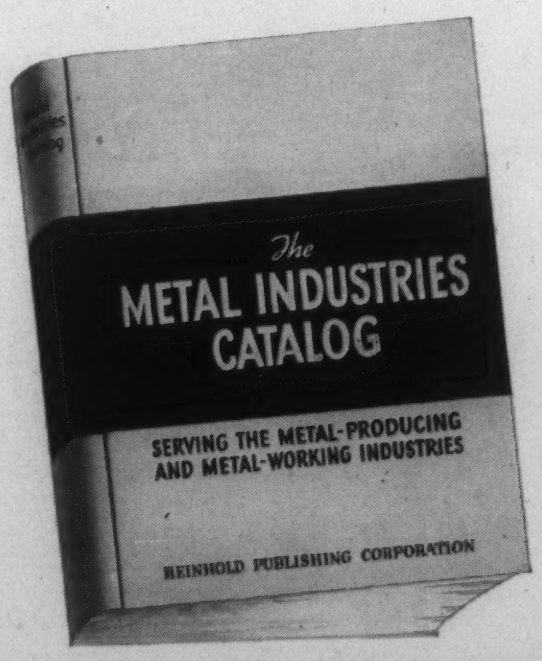

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Metal Industries Catalog

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trends

By Edwin F. Cone, Editor

Steel, New Yardstick for Oil

"Steel, not dollars, will be the measure of value in the petroleum industry for the duration," an oil trade paper suggests.

The oil industry, in normal times, is the second largest consumer of steel in the country, it is suggested, and steel is getting scarce. Every branch of the industry uses large quantities of steel. With buying cut to the minimum for defense and war needs, it will need nearly 6,000,000 tons in 1942, says the Office of Petroleum Coordinator.

The same trade paper suggests that the criterion of value from now on will have to be for steel: "Is the projected operation—drilling a well, building a tank, ship or refinery—worth the steel that will have to be used?"

Copper in Copper-Bearing Steel

Some rather interesting data have been made public by the Amer. Bur. of Metal Statistics on the use of copper in the production of copper-bearing steel. In 1941 there were 12 companies which made 1,816,218 gross tons of this grade of steel into which they put 4,941 net tons of copper or 5.44 lbs. of Cu per ton of steel. For a period of 13 yrs. the average per ton of steel has been 5.46 lbs. of Cu with the high at 5.80 lbs. in 1938 and the low at 4.86 lbs. in 1931.

Zinc in Germany

Because of a fairly ample supply of zinc in Germany, it is finding some out-of-the-ordinary applications. An article in the *Metal Bulletin*, quoted in *Steel*, states that Germany is using small coins made of ordinary commercial spelter, and that uniform buttons have been made of sheet zinc for some time. These buttons are brazed, coppered, etched or lacquered, so that they can scarcely be distinguished from previous ones of brass, copper or aluminum. Many other products are being made of zinc or zinc alloys.

Less Stainless Steel This Year

A representative of a large producer of stainless steels is quoted as having stated recently that the total output of this type of steel will be less in 1942 than in 1941 due to the tightness in the chromium and nickel situation.

Earnings of Steel Companies

Net earnings of the American steel industry during 1941 amounted to about 6.2 cents on each dollar of sales and the sales volume last year was the largest on record. It was 50 per cent in excess of that of 1940 and the earnings per dollar of sales declined 25 per cent. In 1940 the industry's profit was 8.1 cent per each dollar of sales. For 1942 the earnings are expected to be even lower than in 1941.

The return on aggregate investment last year was 8.1 per cent, compared with 7.5 per cent in 1940 and 9.2 per cent in 1929. Despite increased output and sales the trend of earnings is downward.

Electric Steel

Production of electric steel this year is expanding rapidly. According to the data of the American Iron and Steel Institute the electric steel ingot and castings (not all of this) output for the first 4 mos. of this and last year has been as follows in net tons:

	1941	1942
First quarter	595,836	906,546
April	225,999	321,023
Total	821,835	1,227,569

This is an increase to May 1, this year, of 405,734 tons or 49.3 per cent—a significant expansion.

Draft Deferments in Steel Industry

Of a total of 21,984 steel employees who entered the nation's armed services during the approximately 15 mos. ended Dec. 31, 1941, 19,601 were inducted into or volunteered for service in the army. Of a total of 21,780 requests for occupational deferment of steel workers up to Dec. 31, 1941, 18,054 were granted, 1,273 were denied and 2,543 were still under consideration by the local boards.

Safety in Welding

Increased attention paid to the safety, comfort and convenience of welding operators has been one of the significant trends of the past year. This is evidenced by the use of high grade accessories such as ventilated welding helmets and fully insulated electrode holders.

Larger Blast Furnaces

That the trend is towards larger blast furnaces in this country is illustrated by the fact that several stacks made in excess of 40,000 net tons of pig iron per month last year. This is at the rate of over 1,000 tons per day.

British Women Welders

Many women are turning to welding in Britain. There are reported to be two distinct camps—those who like the fireworks of electric arc welding and those who prefer fusion welding. "It is often very difficult to get women to transfer from one method to the other."

Research

According to the 7th edition of Bulletin 104 of the National Research Council, which is a directory of industrial research laboratories in the United States, there are now 2,000 companies which maintain research departments. This is an increase of about 25 per cent since 1938 when the last previous edition was published.

(Additional "Trends" on page 1094)

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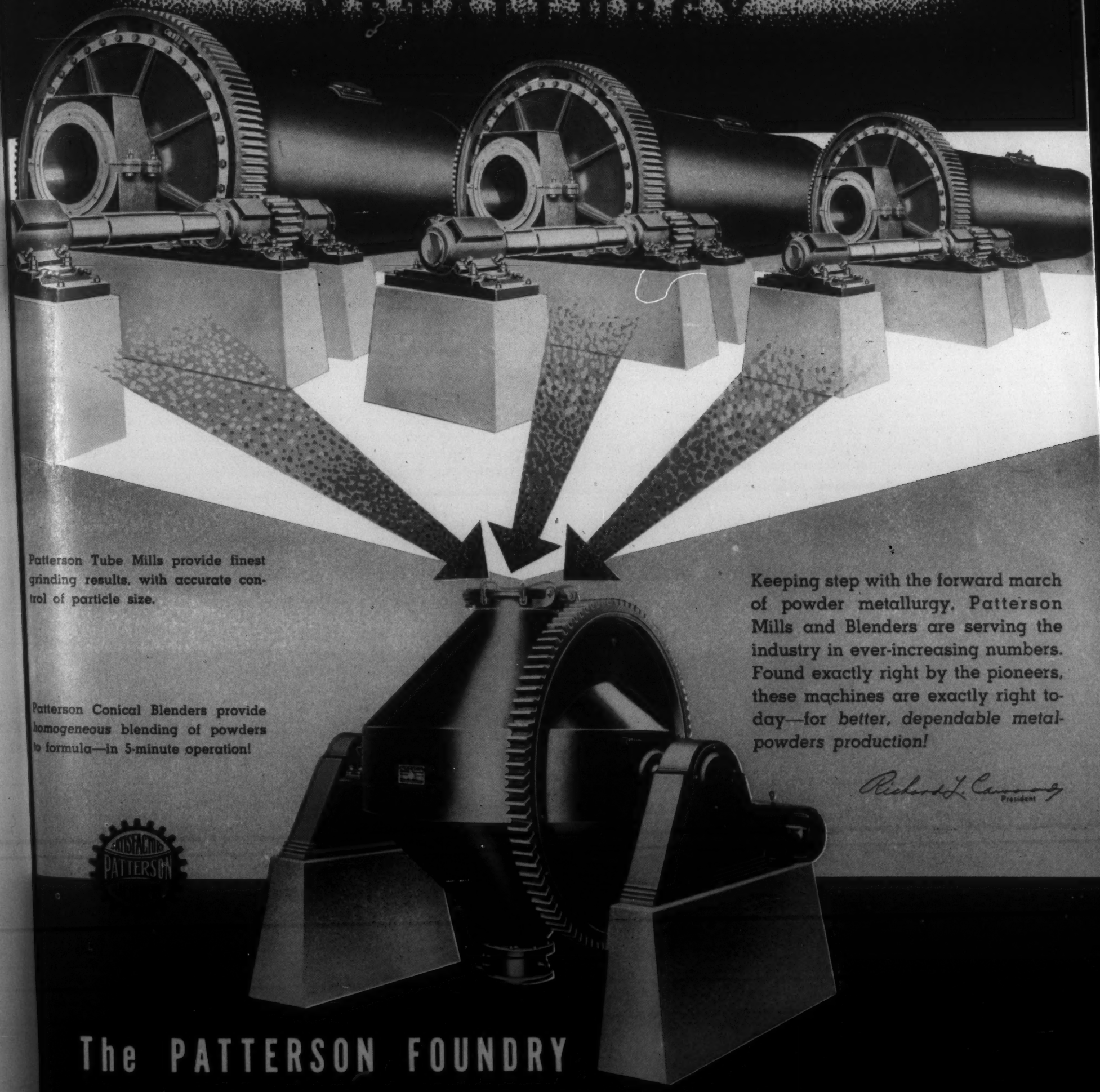

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trends

By Edwin F. Cone, Editor

Conserving Metals in Railroad Equipment

The Association of American Railroads was not slow in cooperating with the Government in the conservation and substitution program for metals and other materials. According to comment in the *Railway Age*, a large amount of copper is used in a modern steam locomotive and other equipment. It has been found, as a result of research and study, that over 500,000 lbs. of copper can be saved. This was based on the use of modified designs in journal bearings on equipment in general; by substituting gun iron with Babbitt inserts on crosshead shoes; by a substantial reduction in the use of sheet copper and the discontinuance of copper-bearing steel sheets on cars and locomotives; substitution wherever possible of iron or steel for brass or bronze bar stocks, and so on.

Records in Pig Iron Output

A new record in American blast furnace production, both daily and monthly, has been made by the Zug Island furnace of the Great Lakes Steel Corp.—43,478 tons for a month and 1,608 tons for the final day. These data are about 40 per cent ahead of the average for a large furnace before Pearl Harbor. The previously claimed world record was 41,782 for one month by a Pittsburgh furnace. The Zug furnace, "the largest in operation anywhere," was completed in 6 mo. as against 18 mo. ordinarily. The acclaimed 1,000-ton furnace is rapidly approaching a 2,000-ton a day rate.

Steel Welding Wire

A new high record in the production of steel welding wire was made in 1941 at 453,120,000 lbs. or 226,560 net tons. This was 90 per cent greater than that made in 1940 and 147 per cent in excess of that made in 1939. From 1932 to 1941 the production of welding wire rose 1,776 per cent. Put in another way—for each ton of finished steel made in 1941, over 7 lbs. of welding wire were made compared with 5 lbs. in 1940. In 1932 about 2.6 lbs. were made for every ton of finished steel products.

The sharp increases shown by these data reflect in part the heavy production of war equipment of all kinds.

Steel's "400"

The WPB recently prohibited the manufacture of some 400 items usually made of steel and iron. The division of information of the OEM has issued a partial detailed statement of what this means in the shifting of this steel and iron to the making of war materials. A few of these striking examples are as follows.

The 10,000 lbs. of steel that in one year went into blackhead squeezers will make 1,000 3-in. trench mortars, or 4,400 0.30 caliber machine guns or 3 15-in. tanks.

The 630,000 lbs. of steel and iron that were used in 1941 to make manicure scissors can now be used for 19,687 4-in. shells or 162 0.37 mm. anti-aircraft guns.

With the 16,000,000 lbs. of steel that went into hair and bobby pins, 160,000 0.50 caliber machine guns can be produced.

Four battleships or 2,200 medium tanks can now be made with the 80,000 tons that went in one year in metal signs.

This recital could be continued almost indefinitely, but it indicates a definite trend.

Steel in 1942—85,000,000 Tons

Our steel capacity as of Jan. 1, 1942, was about 88,500,000 tons, according to President Tower of A.I.S.T. "But until larger supplies of metallics, iron ore and scrap, can be had, it is doubtful whether recourse to all possibilities will suffice to keep steel tonnage up to the rate prevailing so far this year, or a total of 85,000,000 tons for all of 1942." Something over 7,000,000 tons of steel are being made every month.

Our Steel Expansion Program

"Under the circumstances, a steel expansion program, planned to add some 10,000,000 tons of ingot capacity, has little chance of making any early contribution to steel supply for war uses. In fact, it already seems doubtful whether that program will be completed."

"The facts suggest, therefore, that the war effort over the balance of this year and well into 1943 will have little, if any, more than the current volume of steel output."—From W. S. Tower's annual address to the steel institute.

The Steel Industry's Problems

Four pressing problems now face the steel industry of this country, said W. S. Tower in his annual presidential address to the steel institute: How to satisfy its clamorous critics. How to reconcile exacting demands to limitations imposed by critical materials. How to resist forces which contribute to inflation. How to preserve an industry where men are free to work.

And these problems are growing in number and complexity.

Steel Plates

Our steel plate output is now colossal. March shipments to Government departments and agencies exceeded 500,000 tons or as much as average monthly shipments to all classes of users last year, said W. S. Tower in his annual address to the Steel Institute last month. The April and May figures were much higher and June may be a full 50 per cent above March. In the week ended May 16, about 220,000 tons were rolled, of which 94,000 tons came from adjusted strip mills.

(Additional "Trends" on page 1092)

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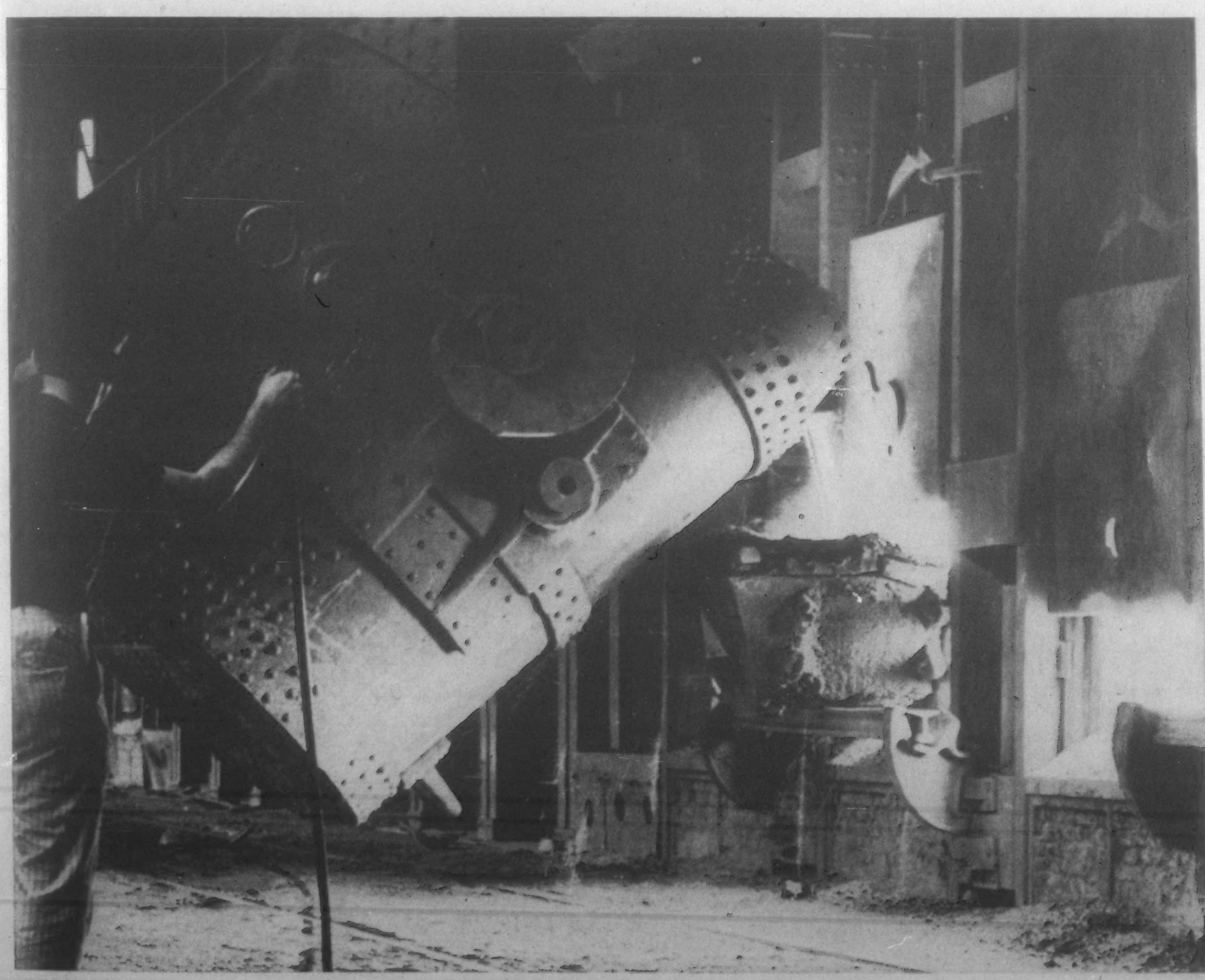

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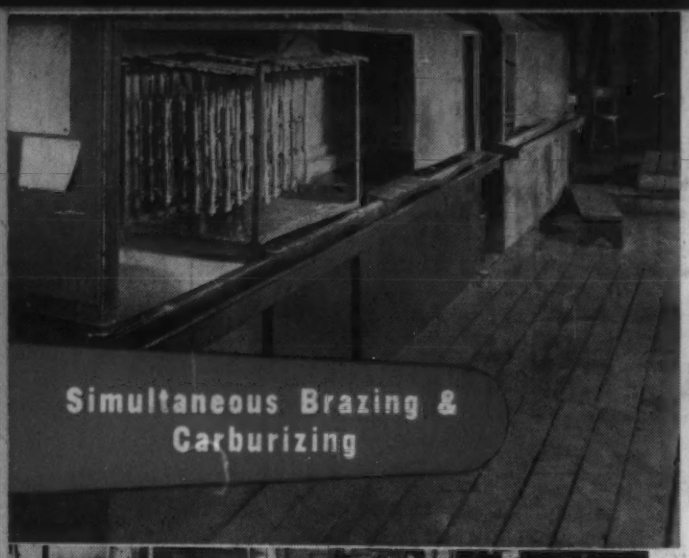

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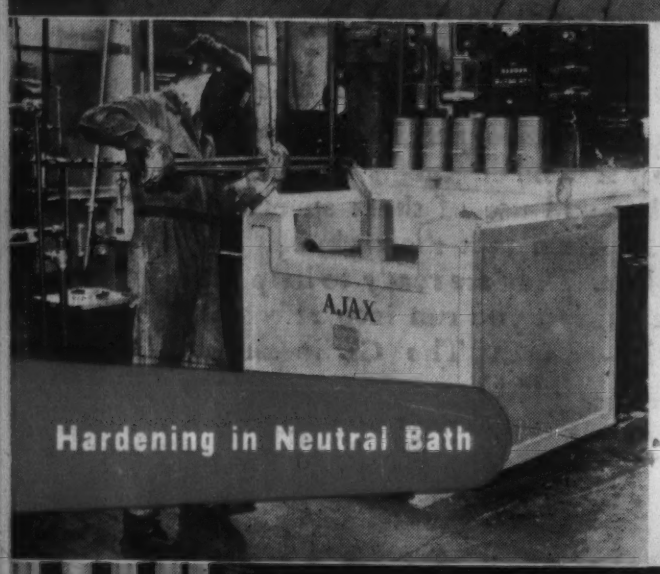
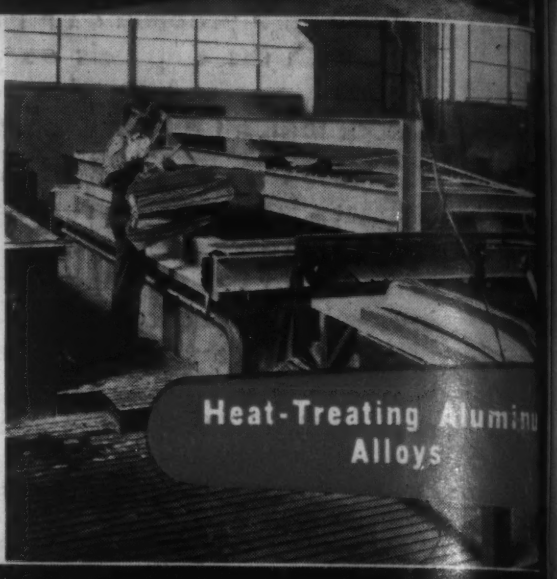
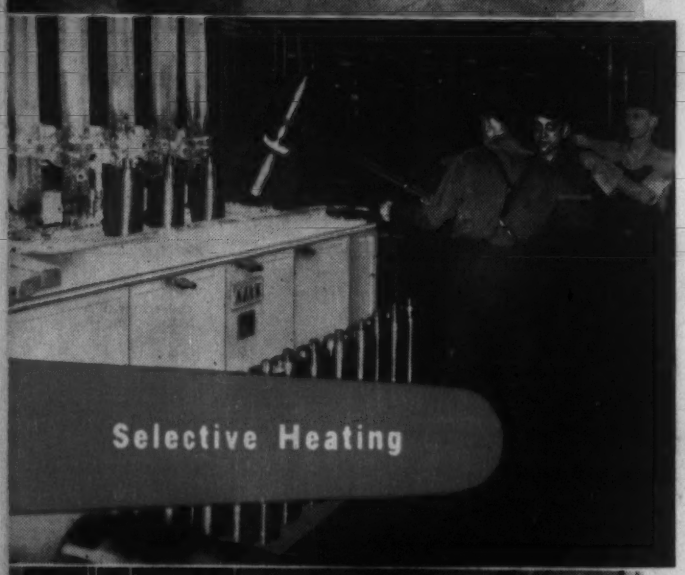


Hardening in Neutral Bath



Heat-Treating Aluminu Alloys



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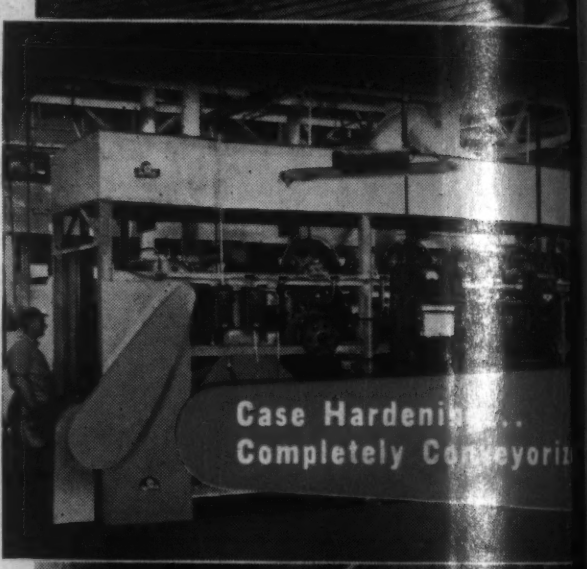

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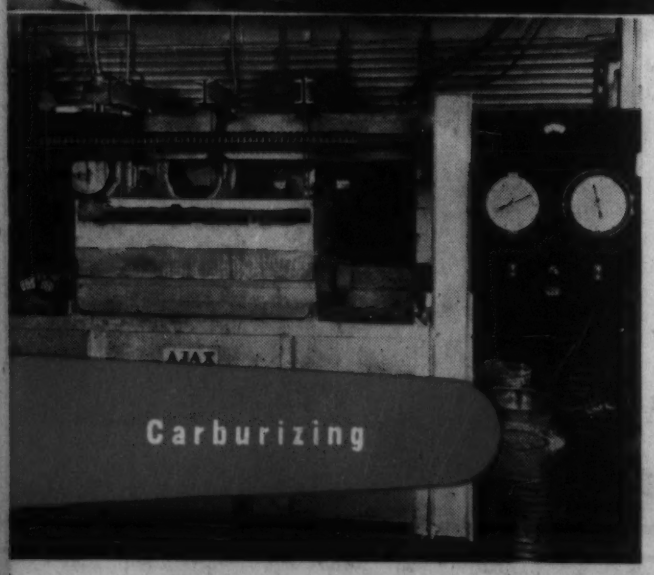

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